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An English Multiple Spindle Drilling Machine.

We present on this page two views of a twenty-four-spindle drilling machine, which was built especially for drilling the rivet holes in the knife bars and finger bars of reapers.

The holes vary in size from $\frac{5}{16}$ inch to $\frac{7}{8}$ inch, and are drilled through bars of from $\frac{1}{4}$ inch to $\frac{5}{8}$ inch thickness.

Each of the spindles of the machine runs in an independent head which can be adjusted laterally to vary the center to center distance slightly, and the spindles have a vertical adjustment to compensate for varying lengths of drills. The pulleys are placed alternately one above another in order to get the necessary clearance.

The drive is obtained from the horizontal back shaft shown, which drives four upright shafts through miter gears, and each upright shaft carries a double pulley on its upper end.

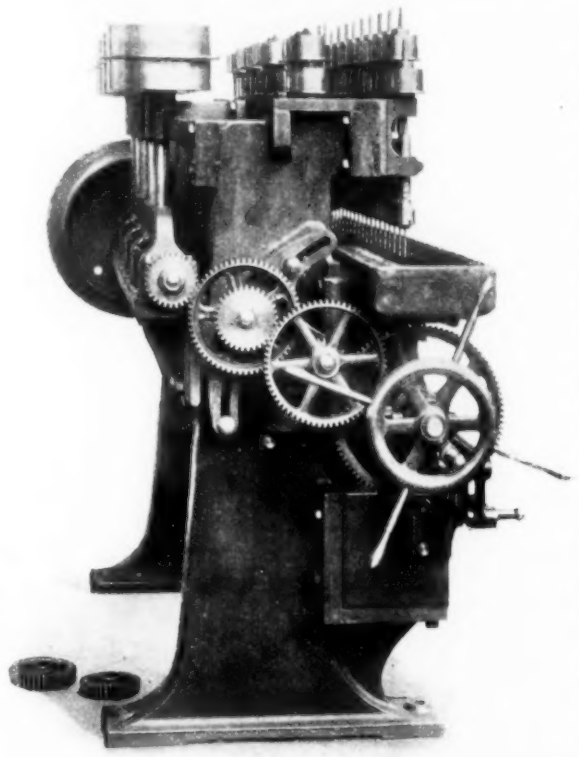
By means of suitable idlers a belt is carried from the upper pulley on the upright shaft around three of the upper pulleys on the drill spindles, and another similar belt leads from the lower pulley on the upright shaft around three of the lower pulleys on the drill spindles, so that each of the four upright shafts drives a group of six spindles.

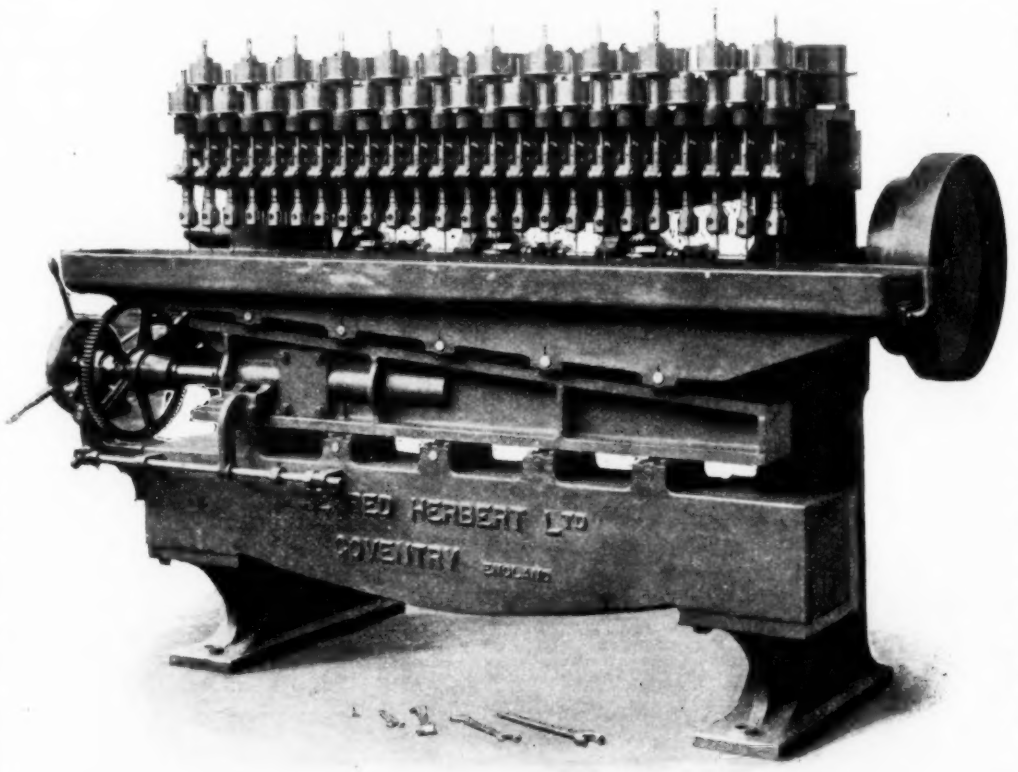
The feed motion is obtained from a wedge bearing on rollers. This wedge being fed forward by a screw raises the table.

The feed is automatically thrown out by means of the arm on the wedge which strikes the tappet collar shown on the shifting rod below, and the rate of feed is varied by change gears.

The table is formed so as to carry sufficient suds to cover the job, thus securing thorough lubrication.

Jigs are used to hold the job and to accurately locate the holes.





AN ENGLISH MULTIPLE SPINDLE DRILLING MACHINE.

Paper Punching.

BY OBERLIN SMITH.

This is not intended, as perhaps its name might indicate, for a complete treatise upon the subject, but is merely the record of a few casual experiments which possibly may be of interest to the readers of the AMERICAN MACHINIST, inasmuch as there probably has not been much information published upon the subject—at any rate not to my knowledge.

The object of the experiments referred to was: 1st, to ascertain the best angle of cutting edges for ordinary male and female dies, when used in cutting paper and pasteboard; 2d, to see how many thicknesses could be successfully cut under various conditions; 3d, to note the pressure required. For this purpose a pair of round dies cutting to a diameter of 1¼ inches was used, a section and top view of the same being shown in Fig. 1, next page.

In the first batch of experiments the punch and die were both made perfectly flat with the angles *A* and *B* each 90 degrees, the edges being sharp and the punch fitting the die with a close but easy sliding fit, say, not over one five-thousandth of an inch loose.

The second condition of the dies was as in Fig. 2, with the lower die still flat, and the punch beveled out so as to make the angle of cutting edge at *A* 60 degrees, which angle seemed to be (after a few trials with other inclinations) the most appropriate for the purpose.

Under condition third the punch was flat and the die beveled to an angle of 60 degrees, as in Fig. 3.

Under condition fourth both punch and die had their edges beveled at *A* and *B*, to angles of 60 degrees.

With dies in condition first, from one to five sheets of manilla paper, .012 inch thick, could be cut at a time when piled together, the cutting being reasonably smooth. When ten were cut at a time some of them were rough and ragged, and with twenty at once, what might perhaps be termed the "ragged edge of despair" was reached, the roughness being too great for any ordinary purposes, both with the "blanks" and "margins"—these terms being used to designate respectively the round pieces cut from the sheet, and the pieces of the sheet remaining around the holes from which these blanks were punched. With pasteboard .057 inch thick (one sheet at a time) the cutting was very good, and with two sheets at a time, slightly ragged. With pasteboard of a softer quality, .105 inch thick (one sheet at a time) the cutting was fairly good only, being slightly ragged. In all these cases, as might be expected, both blanks and margin remained flat.

Under condition second, much smoother edges were produced when cutting a number of sheets at a time, on account of the sharp angle of the punch—work almost smooth being produced ten at a time, and fairly good twenty at a time, the pasteboard also showing better results than before. As might be expected, however, the paper blanks were bent upward into the concave recess of the punch, when cutting more than about five or six at a time, to an extent calculated to render them useless for ordinary purposes. This was especially the case in cutting twenty at once, a number of the uppermost blanks in the pile being very much wrinkled, and the pasteboard blanks showing a raised bead near the edge caused by the radial compression. As might also be expected in this case, the margins remained flat, without injurious wrinkles.

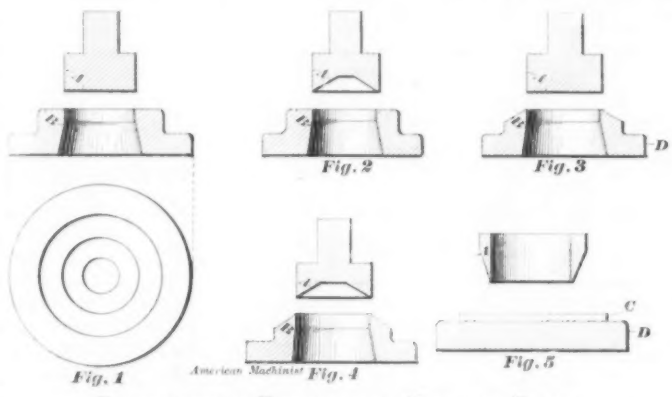
Under condition third, with the punch flat, and the die having an edge whose section was an acute angle, the expected happened, the paper blanks being flat and smooth all the way through, and the margins being permanently bent and wrinkled when cut in piles of more than five or six sheets at a time—so much so as to render them unfit for ordinary use. With twenty sheets at a time the lowermost margins were embossed out to a cup-shape where they were forced over the conical portion of the lower die to about $\frac{3}{16}$ inch deep, while the central ones of the pile had a depressed flange something on the counterbore order, the uppermost ones being nearly flat, but slightly wrinkled. In the case of the pasteboard something of the same effect occurred, but not to so great an extent.

Under condition fourth the cutting was still smoother than in any of the other cases, with less of the ragged edge effect, even twenty sheets at once being cut in fairly good shape. As might be supposed, however, the evils cited in the last two paragraphs, viz., cupping and wrinkling of the blanks, in the one case, and of the margins in the other, were here united as twin evils, although the distortions did not seem to be quite as great in either case, as under the other conditions.

In regard to the actual and relative pressures required for paper punching under the various conditions named, no accurate records were kept, as the only means at hand for weighing said pressures was an extemporized lever attached to the fly wheel of the small power press in which the dies were mounted, this lever being balanced, and readings being taken from a large spring balance attached to the end of it, some six feet out from the press shaft. No very definite results could be obtained from this arrangement on account of the very large friction coefficient present in the bearings of the press, this being aggravated by the abnormally large crank and journal bearings, which this particular machine happened to possess. The friction was also increased by the weight of the fly wheel, as well as that of the lever itself, and its counterpoise. As nearly as I could estimate the total friction approached 50 per cent., but as this was partly guesswork the pressures given below must be taken for what they are worth, and be reckoned as a very rough approximation.

Upon such a basis it was found that the net pressure for ten sheets at a time of .012 inch paper, with the flat dies, Fig. 1, was about

3,400 pounds; with the beveled punch, Fig. 2, about 1,200 pounds; with the beveled die, Fig. 3, about 1,200 pounds, and with both die and punch beveled, as in Fig. 4, about 1,000 pounds. The average pressures per square inch of section cut, for 5 to 20 sheets of paper at a time, and 1 or 2 of pasteboard, taken from a number of experiments, were, for the four conditions named, respectively 5,800, 2,650, 2,350, and 2,150 pounds, approximately.



EXPERIMENTAL PUNCHES AND DIES FOR PAPER.

Thus we see that the pressure required with the dies flat is much greater than with one or both edges beveled, and that with such flat dies the pressure per square inch area of section sheared is nearly 6,000 pounds, while with beveled dies it is less than half as much. At some future time I hope to present an amended report, so to speak, regarding this question of pressure—as soon indeed as I can get ready a rational testing apparatus.

From the above-named results it will be seen that in making dies of this sort for cutting paper, the same general rule may be followed as with dies for sheet metals, especially if such metals are soft and thin. This is that if the blank is required to be flat, and the margin is merely "scrap," the punch should be flat, at any rate for some distance in from its cutting edge, while if the margin is the work which it is required to have accurate, the blank being mere scrap, the converse is true, viz., that the die should be flat some little distance out from its cutting edge, while the punch may be considerably hollowed out.

It is of course true that in the case of metal punching, where the sheets are thick enough and hard enough not to be easily bent or embossed, these rules need not apply except perhaps in the case of giving "dip" (or shear) to the dies, in which case such dip can be given to either punch or die, according to whether it is desired to keep the margin or the blank as flat as possible.

In cases where both margin and blank are required as products of the operation in question, it may be necessary in some cases, especially if a large number of sheets of paper are to be cut at once, to make both punch and die flat, as in Fig. 1, although, as has been shown, with a few thicknesses only this is not necessary.

In Fig. 5 are shown the tools for a more usual method of cutting paper, pasteboard, cloth, leather, etc., than by the use of the male and female dies under consideration. This is simply a hollow cutter with its angle *A* at the cutting edge about 20 degrees, and its depth from 1 inch to 1½ inches. The matrix *C* upon which the cutting is done is usually a sheet of copper, soft brass, lead or pasteboard, the latter being probably the most frequently used. This rests upon an iron plate *D* set upon the bed of the press. In some cases, however, a wooden anvil, preferably with the end grain toward the cutters, is used in place of the plate *C*. The cutter is usually placed by hand upon the pile of paper sheets, which are slid under the ram-driven platen of the press. This of course descends upon the top of the cutter, and pushes it down exactly in contact with *C*. The blanks are usually removed by hand, although in some cases the cutter is reversed, and so mounted upon a lower die plate (something after the fashion of Fig. 3) that the blanks may fall through of themselves as they are pushed down by the following blanks in succeeding operations. In still other cases they are pushed upward by an automatic knock-up, worked by springs or otherwise, and in either of these last-named cases a spring stripper is sometimes furnished for pushing the pile of margins off from the outside of the cutter, instead of removing them by hand.

In some recent experiments I found that a cutter of this kind would cut smoothly some 300 thicknesses of ordinary printing paper at a time, the whole pile being about 1 inch thick. The pressure per square inch of section cut was, roughly speaking, about 2,000 pounds for large diameters, and about 25 per cent. more for small sizes of an inch or two across—for the reason to be cited in the final paragraph.

The purposes for which paper is cut in definite shapes are of course too numerous to mention here. Among them are playing cards, photographic cards, blanks for paper boxes, all sorts of fancy labels, ornamental decorative work, and, in accordance with what seems to be a somewhat recent boom, paper dolls of every imaginable shape, size, complexion, and degree of ugliness.

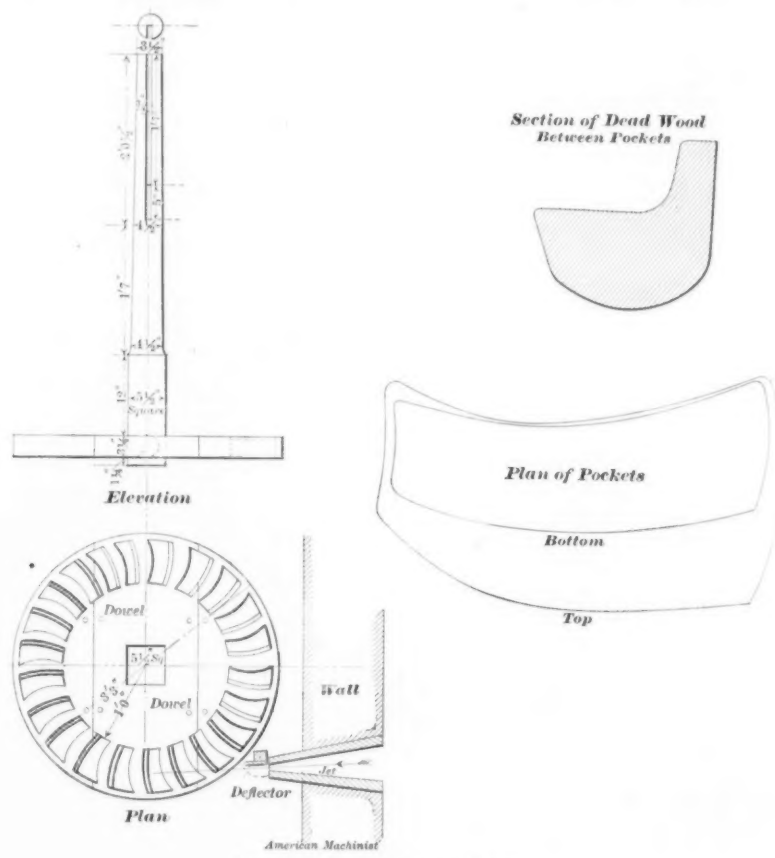
It will be noticed that the dies used in these experiments were of rather small diameter. It is obvious that the wrinkling evil would be apt to occur in less degree with larger sizes. The pressure per unit of section cut would probably be somewhat less also, as stretching and compressing, by the bevel of the dies, would be distributed over a larger circumference. Especially would this be the case with cutters like Fig. 5, which penetrate deep into a thick pile of paper.

Jet Turbine Used in Asturias, Spain.

The province of Asturias, in the north of Spain, is separated from the rest of the country by the configuration of the great range of Cantabrian mountains, and is in parts very undeveloped. The hillsides abound in streams, which have been for centuries utilized to provide power for grinding the maize abundantly grown in the district. The type of water motor in general use is in advance of common forms of wheels customary in such inaccessible localities, and presents features of considerable ingenuity on the part of such unsophisticated folk as the mountaineers.

It is illustrated in the drawing herewith, from dimensions taken on the spot. The wheel and spindle, which is vertical, are entirely of wood, the former generally of hard chestnut, and the latter of Spanish oak. The disk is made of three slabs doweled together with oak pins, and the wheel rotates on a hardwood nipple or center cone set in a stone base. The cups or pockets are hand-carved, as shown in detail, and are designed to receive the water in the form of a jet about 4 inches wide by 1½ inches thick, emerging from a wooden spout or rough *cena contracta* set at an angle above the wheel face, and at a tangent to the mean radius of the pockets. A deflector or shutter is fixed on a vertical post, extending to the mill above, alongside the jet, and serves to divert the stream to the exact position found to give best results. The arrangement is shown on the plan.

The supply is usually brought by long and rather leaky ditches along the hillsides to the back wall of the mill, whence it is led to the wheel-race by a hollow tree trunk. The capacity does not often exceed 100 cubic feet per minute of water flow, with a fall of 5 meters (16 feet 4 inches). Such a supply would correspond to a theoretic power of 3 09 horse-power, or about 2.14 horse-power at an efficiency of 75 per cent. The wheel shown, which is 3 feet 3 inches diameter, runs, under above circumstances, about 115 revolutions per minute, driving a millstone a meter in diameter keyed to the wood spindle by an oak cotter in the slot shown.



JET TURBINE USED IN SPAIN.

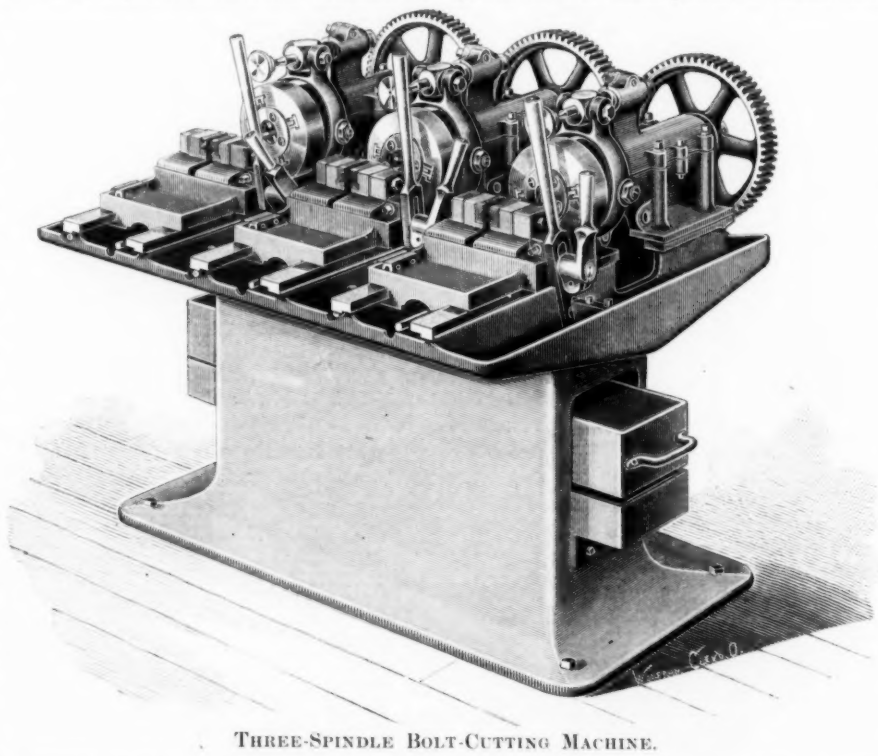
Just how far back the use of these wheels extends it was impossible to ascertain, but certainly far beyond the memory of living inhabitants, and the ancient appearance of many of the mills would lead to the supposition that they may have been centuries in use. Furthermore, no change has taken place in the construction of the other simple apparatuses of the Asturians, such as plows, wagons, or hand-kibbling mills, for many centuries, and it may therefore be reasonably assumed that in this jet turbine we have the progenitor of the modern turbine and "hurdy-gurdy" wheels.

REGINALD PELHAM BOLTON,
M. Inst. C. E.

[The wheel described by our correspondent seems to be almost identical with the Pelton wheel, except that the spindle is vertical. The drawings are reproduced precisely as received. The bearing point for the bottom of the spindle seems to be very small.—ED.]

Three-Spindle Bolt-Cutting Machine.

We present herewith an engraving of a three-spindle bolt-cutting machine designed especially for manufacturing purposes, to produce as large a quantity of work as is possible for a single operator to handle, and still to run the machine at a rate of speed that will insure long life to the machines and dies, and produce good work.



THREE-SPINDLE BOLT-CUTTING MACHINE.

These machines are very compact, all parts being within easy reach of the operator. There are holes in the bed directly under each head allowing the oil and chips to fall on to the pan, which has a screen bottom and capacity sufficient to hold the chips of the day's work, where they can be left to drain over night, and the pan can be readily drawn out and emptied in the morning.

The carriages are long, giving ample bearing. The long levers move the carriages. The short levers close the vises and are adjustable to any angle. This makes the movement of both carriage and vises very quick and easy.

The heads are the latest improved Acme (and use their well known form of die) made with extra long die rings, lined with tool steel blades throughout. They are some 5 inches shorter in total length than the usual form of Acme head. The yoke which opens and closes the head is locked by a toggle between the lower end of the yoke and the head stock. The upper end of the yoke is

connected with the nut that works on a screw having a knurled head, and the dies are thus adjusted to size by means of a knurled head screw, without stopping tho machine. The lower end of this yoke is connected to the carriage by a rod directly under the center of the carriage having adjustable stops, so that the forward and backward movement of the carriage opens and closes the head automatically.

The machine is built by The Acme Machinery Company, Cleveland, Ohio.

The Adiabatic for Perfect Gases.

BY G. A. GOODENOUGH.

In working up tests of air compressors, blowing engines or other pneumatic machines, it is often necessary, or at least desirable to draw the curves representing the adiabatic, or the isothermal expansion (or compression) of air.

The isothermal is the well-known equilateral hyperbola; its construction is easy and familiar to engineers. Unfortunately, this is not true of the adiabatic; unlike the isothermal it has no properties which enable us to locate points by simple geometrical constructions, and usually the only resource is to simply calculate the co-ordinate of a series of points from the equation of the curve. Those who have had to go through such a series of calculations well know what a tedious operation it is.

A little study of the equation of the curve, however, discloses some properties which may be used to very materially shorten the work of calculating the co-ordinates of the points.

The equation as usually written is

$$p\ V^n = \text{constant} \qquad (1)$$

or $p_1\ V_1^n = p_2\ V_2^n = p_3\ V_3^n = \text{etc.}$, (2)

where $(p_1\ V_1)$, $(p_2\ V_2)$, $(p_3\ V_3)$, etc., are co-ordinates of points on the curve.

$$\text{From (2)} \quad \left.\begin{aligned} p_2 &= p_1 \left(\frac{V_1}{V_2}\right)^n \\ p_3 &= p_2 \left(\frac{V_2}{V_3}\right)^n \\ p_4 &= p_3 \left(\frac{V_3}{V_4}\right)^n, \text{etc.} \end{aligned}\right\} \qquad (3)$$

The abscissas of the curve represent volumes; let us so choose these abscissas that

$$\frac{V_1}{V_2} = \frac{V_2}{V_3} = \frac{V_3}{V_4} = \ldots = C.$$

That is, the abscissas laid off along the horizontal axis are in a geometrical progression with a ratio C. Then (3) becomes

$$\left.\begin{aligned} p_2 &= p_1\ C^n \\ p_3 &= p_2\ C^n \\ p_4 &= p_3\ C^n \end{aligned}\right\} \qquad (4)$$

Taking logarithms of both sides of (4), we have

$$\left.\begin{aligned} &\text{log. } p_2 = \text{log. } p_1 + n \text{ log. } C; \\ &\text{log. } p_3 = \text{log. } p^2 + n \text{ log. } C; \\ &\text{log. } p_4 = \text{log. } p^3 + n \text{ log. } C. \end{aligned}\right\} \qquad (5)$$

Equations (5) show that the logarithms of the pressures form an arithmetical progression with n log. C as the common difference.

The practical application of this method is shown in Fig. 1. We wish to pass an adiabatic through the point a', say. Then to some scale $O\ a$ represents V_1, the initial volume, and $a\ a'$ represents p_1, the initial pressure. We now lay off $O\ b = \frac{4}{5}\ O\ a = V_2$ and $O\ c = \frac{4}{5}\ O\ b = V_3$. That is, the volumes fulfill the condition

$$\frac{O\ a}{O\ b} = \frac{O\ b}{O\ c} = \frac{O\ c}{O\ d}, \text{ etc.,}$$

or $\frac{V_1}{V_2} = \frac{V_2}{V_3} = \frac{V_3}{V_4}$, etc., $= \frac{5}{4}$ in this case.

The volumes are easily laid off thus in a geometrical progression by means of the simple construction shown below the line $O\ V$. The proof is as follows: From the similar triangles $O\ a\ p$ and $O\ b\ q$ we have $\frac{O\ p}{O\ q} = \frac{O\ a}{O\ b}$; from the similar triangles $O\ b\ p$ and $O\ c\ q$ $\frac{O\ p}{O\ q} = \frac{O\ b}{O\ c}$. Therefore $\frac{O\ a}{O\ b} = \frac{O\ b}{O\ c} = \frac{O\ c}{O\ d}$, etc.

Through the points b, c, d, e we draw verticals which are, of course, simply prolongations of the lines $b\ p$, $c\ q$, $d\ r$, etc.

The next operation is the calculation of the pressures p_1, p_2, p_3, etc. In the figure $a\ a' = .3$ inch (corresponding to 15 pounds per inch with a 50-indicator spring).

The numerical work is as follows:

$$p_1 = .3\ ;\ n = 1.41\ ;\ c = \frac{5}{4} = 1.25\ ;$$

$$\text{log. } p_1 = \text{log. } .3 = \bar{1}.47712$$
$$n \text{ log. } c = 1.41 \text{ log. } 1.25 = \quad .13664$$

$$\text{log. } p_2 = \text{log. } p_1 + n \text{ log. } c = 1.61376$$
$$\text{likewise log. } p_3 = \bar{1}.75040$$
$$\text{log. } p_4 = 1.88704$$
$$\text{log. } p_5 = \quad .02368$$
$$\text{log. } p_6 = \quad .16032$$
$$\text{log. } p_7 = \quad .29696$$

Each log. is obtained by adding 13664 to the next preceding one, and it is evident that any required number of ordinates can be found with very little labor.

From the above logarithms we obtain

$p_2 = b\ b' = .41$ in.	$p_5 = 1.06$ in.
$p_3 = c\ c' = .56$ "	$p_6 = 1.45$ "
$p_4 = d\ d' = .77$ "	$p_7 = 1.98$ "

In practical work it is generally required to draw a compression curve starting from some point near the line $O\ V$, as was done in Fig. 1. If, however, it is desired to draw an expansion curve starting from some point near the vertical axis $O\ p$, as, for instance, from the point h', Fig. 1, it will be found more convenient to arbitrarily choose the pressures in a geometrical progression and to calculate the volumes. In this case

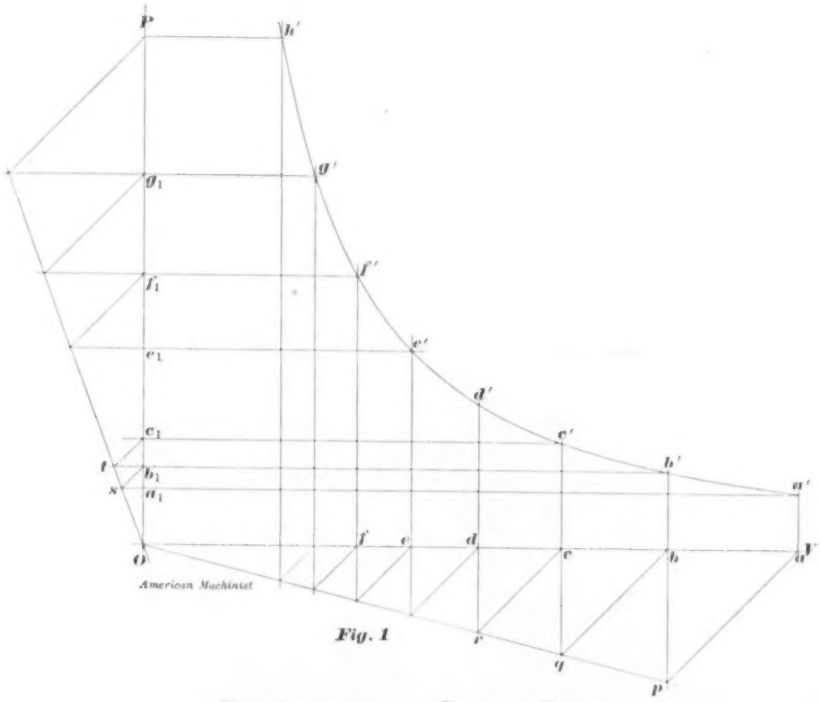


Fig. 1

THE ADIABATIC FOR PERFECT GASES.

$$V_2 = V_1 \left(\frac{p_1}{p_2}\right)^{\frac{1}{n}} = V_1\ C^{-\frac{1}{n}},$$

$$\text{or log. } V_2 = \text{log. } V_1 + \frac{\text{log. } c}{n};$$

$$\text{log. } V_3 = \text{log. } V_2 + \frac{\text{log. } c}{n}, \text{ etc.}$$

It is seen from equations (4) that if the volumes are chosen to form a geometrical progression, the pressures will also be in a geometrical progression. (Since $\frac{p_2}{p_1} = \frac{p_3}{p_2} = \frac{p_4}{p_3} = C^n$).

This fact suggests the following construction. After obtaining the point b by calculation project the points a' and b' across to the vertical $O\ P$, giving the points a_1 and b_1. Continue the line $a'\ a_1$ and draw the line $b_1\ s$ intersecting $a'\ a_1$ in s. Draw the line $o\ s$ intersecting the line $b'\ b_1$ at t. Now draw $t\ c_1$ parallel to $s\ b$ and intersecting the axis $O\ P$ at C_1. Then $\frac{O\ C_1}{O\ b_1} = \frac{O\ b_1}{O\ a_1}$; that is, $O\ c_1 = p_3$.

In a similar manner the other points may be found. In actual practice this construction is perfectly useless, simply because we must begin at the small end, and the small error (which is sure to be made) is multiplied as the construction proceeds.

Since one ordinate must be calculated in any case, it is very little more work to calculate all of them and insure the accuracy of the curve.

The above method may be found useful in drawing other curves belonging to the same family, *e. g.*, $p\ V^{\frac{17}{16}} = \text{const.}$, $p\ V^{\frac{10}{9}} = \text{const.}$, etc.

Technical vs. "Liberal" Education.*

We offer our readers one or two suggestive extracts from a paper by Dr. C. M. Woodward, of the Engineers' Club, of St. Louis:

The history of civilization has been the history of masters and slaves, of caste, of contempt for all labor and for all useful arts. No wonder that Plato held that the useful arts were degrading, for they brought one into the companionship of slaves, for even in Athens every freeman lived in luxury on the labor of several slaves. Caste prejudices were equally strong in Milton's time in England, so that Milton places Memnon, the chief engineer and architect of the hosts of heaven, among the fallen angels. In spite of his energy, his knowledge of ores and their treatment, and his marvelous skill in construction,

> He was headlong hurled
> With his industrious crew to build in hell.

The technical professions are all less than one hundred years old. They are all evolutions from trades. The first mechanical engineers built their own engines, and the first electrical engineer built his own dynamo. There is, therefore, an odor of the shop about the names, and a reminiscence of men who were heretics as regards theory, but firm believers in practice.

We all know the intense squeamishness of the average college professor with regard to anything which savors of use. "Thank God, that department can never be made useful," said an eminent professor, speaking of a newly established chair in a State university.

A similar spirit would seem to have prompted Professor Patten, in an article on the "Educational Values of Studies" (see *Ed. Rev.*, Feb., 1891), to say that a study loses its educational value in proportion as its economic value increases. Hence, mathematics and electricity have less educational value now than when they were of less utility. This statement is so incredible that I give his exact words:

"With the increase in their utility they will be of less value in educating men. Whatever makes them more fitted for utility studies, makes them less fitted for general culture." Again, he asked: "Shall a subject be taught with a view of making the student a master of it, and thus enable him to obtain a utility (*sic*) from it? or shall it be taught with the purpose of producing the greatest effect upon the mind and culture of the pupil?" Professor Patten would have no objection to making a student a master of a subject, provided he were sure that the mastery could be of no use to him, for then he would be educating a man as man, and the result would be general culture. But let it be discovered that that mastery enables one to solve a practical problem, to earn a loaf of bread, or to make two blades of grass grow where one grew before, and lo! the man is less a man, the mental effort becomes narrow and undesirable, and what he fondly hoped was culture turns out to be mere "expertness" and "adroitness."

The belief shown by Messrs. Patten and Bryant is widespread, particularly among those who have had no direct contact with technical work. I have seen both kinds of training intimately. I have seen them in separate institutions, and I have seen them side by side in the same institution. So far as relates to vigor of intellect and high character, the influence of technical studies is in no respect inferior to that of the traditional untechnical curriculum. On the contrary (and I am not alone in this opinion), there is a widespread and uniform degree of earnestness and zeal among technical students, rarely equaled in colleges which do not admit technical branches. The sense of responsibility, which accompanies the study of subjects which cannot be slighted without leaving a defective foundation on which to build later, is helpful to serious and steady work. On the other hand, I remember that, in my own college days, it was difficult to look upon much of the college work with any considerable degree of earnestness. It seems to be irrelevant. The idea of thoroughly mastering a subject so that one could base something else upon it, rarely entered the head of the average student. I recently met a college classmate as an officer in a technical school. We fell into conversation as regards the influence of technical study on the development of character. Said he: "The earnestness and manliness of these students has been a revelation to me. There was nothing like this when we were at Harvard."

The engineer is by nature an iconoclast. He has small respect for the traditions. He snaps his fingers in scorn at all whose chief pride and glory lies in their submission to the "tyranny of the ancients." He cares less for what has been than for what may be. His triumphs, his masterpieces, his heroes, his golden age, are all in the future. He walks forward, with his face to the front; not backward, with his face to the past. When Captain Eads proposed to build a steel arch over the turbulent Mississippi with a clear span of 520 feet, the timid worshipers of the past held up their hands in protest that there was no precedent for an arch of such great length. To this unworthy opposition it was said proudly in reply: "The engineer makes precedents; other men follow them."

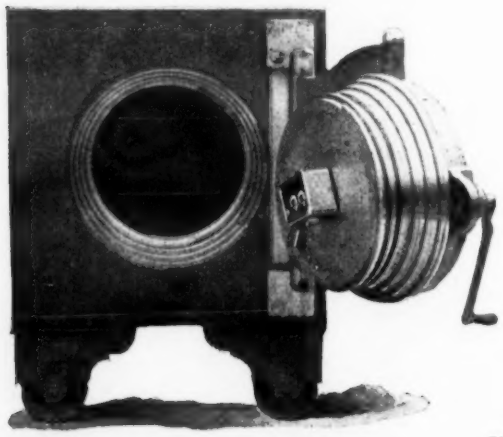
There is another aspect of the effects of our modern liberal technical training, which is somewhat new. In that graceful liberal culture, which we all so much prize, and which we more or less unconsciously set up as a standard for others, we learned how the imaginative Greeks made gods and demi-gods to account for wonderful things. Beings with superhuman strength and skill turned the courses of rivers, built impregnable walls, bore messages faster than the wind, and subdued monsters, drained marshes and warded off disease. Not to know these things is now held to be wanting in the very elements of a liberal education. In these modern days, men have done all these things and more, in fact and not in fancy, and yet to know these modern heroes—men, accomplished, but in no way superhuman—who have dethroned the gods and put demi-gods

* Reprinted from the *Journal of the Association of Engineering Societies.*

to the blush, is held to be not liberal, and such knowledge exposes one to the suspicion of being too familiar with swarthy fellows who handle machinery and despise the ancients. Men are now struck dead by artificial lightning, while the thunderbolts of Jove are turned harmlessly into the earth by a Franklin, and the energy of which thunderbolts are made is harnessed to a car or a mill by an Adams or a Hopkinson or an Edison, and made to serve the peaceful ends of commerce and industry. The dreadful energy of a Maxim gun or of a dynamite cannon is far more destructive than the twanging of Apollo's silver bow and his whole quiver of arrows. The skill of an Eads, which turns the current of the mighty Mississippi and forces it to maintain a new deep channel into the sea, dwarfs into insignificance the labors of a Hercules. The ingenuity of a Morse and a Field sends messages to the antipodes in less time than Mercury needed for binding on his sandals. The roar of Mars could be heard by whole armies; now the whisper of a Brush is heard a thousand miles.

It is now the engineer who turns away the destroying monster, redeems the waste places, brings health, peace and security where there was pestilence and death. Shall not an accurate knowledge of the exploits and rational methods of these modern times and heroes be held to be an essential part of a liberal as well as of a technical education?

Is not the educational army changing front? Is not our new leader an engineer, rather than a philologist or an antiquary? We all believe in culture. The word is much abused; perhaps I have helped abuse it; but there is culture and culture. Whatever broadens one's intellectual grasp, extends his mental vision, purifies his mental taste, lifts him away from individuals to generals, builds rational ideals, is an aid to culture, and, *ipso facto*, is liberal. I urge most earnestly that, as is done in many universities to-day, on the one hand, all narrow, petty, ephemeral matters, which have no logical bearing upon life, be eliminated, and that technical subjects in their most liberal form be incorporated into the college course as possible electives. No longer



should it be true anywhere, as, according to the Emperor William, it is now true in Germany, that they have an overproduction of what are called "over-cultivated men," who, instead of being an element of strength to the State, are a source of weakness, being unfitted for life and its problems. The college student should have free access to all subjects liberally taught, which he may choose according to the quality of his mind or the promptings of his future.

Mechanics of Safe Burglary.

In previous articles on this subject it has been shown how bank safes with square doors are opened by the modern burglar aided by nitro-glycerine. On the principle of grinding the plug of a water cock tight, a type of safes known as "screw-door" safes has come into general use, as superior to the square-door safe, as they unquestionably are in some respects. A square door cannot be revolved, and cannot therefore be ground to a joint like a circular door.

At Pullman, Ill., on April 26, 1895, a specially built screw-door safe was submitted to a test. The claim for the safe was that it was burglar proof for 24 hours. The bank owning the safe desired to have the *real* security offered by this safe made certain by an *actual test*, as a counter claim had been made that the safe was not secure for three hours against a practical burglarous operation, viz., the opening of the safe in three hours in a burglarous manner, so its contents could be abstracted, and without sufficient noise to alarm people 30 or 40 feet away.

Safe makers as a class object to any *practical test* of their safes. But why should they do so? They build a structure and claim that it is burglar proof. What tool builder claiming a tool of his manufacture could turn out a certain quantity of work

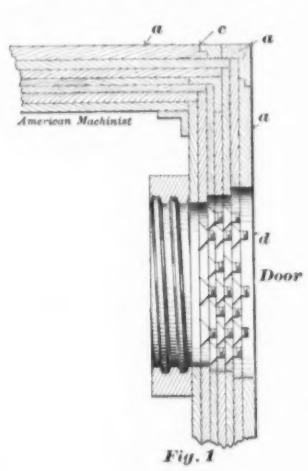


Fig. 1

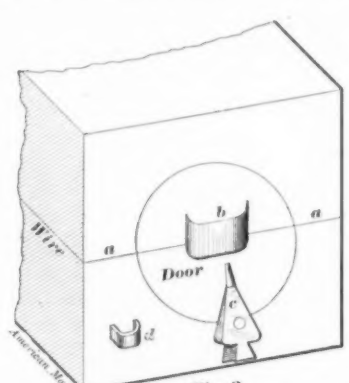


Fig. 2

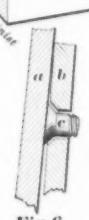


Fig. 6

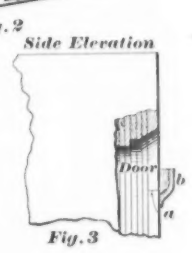


Fig. 3

Mechanics of Safe Burglary.

in a given time, could expect to sell them if he were unwilling that a practical test be made by the purchaser before purchasing, especially if a rival tool builder claimed to build a superior tool in this respect. The purchaser would naturally demand an opportunity to make clear to himself the real value of the two tools offered, and a tool builder who expected to sell tools, the value of which was based solely on his claims, and objected to a practical test of the tool, would soon realize that he was in the wrong business. Claims for any device must, to insure the commercial standing of it, involve a showing of confidence on the part of the builder. A town or city buys a pumping engine, guaranteed to perform a certain amount of work at a given cost. Almost invariably this guarantee is tested by a practical test. Engine builders guarantee certain economic results in flouring mills, electric lighting, etc., and the value of this guarantee is and should be generally tested. But the average safe maker expects the banker to put his faith and money and other people's money as well, in a safe, the security of which depends solely on the maker's unsubstantiated claims.

The construction of the safe tested, Fig. 1, clearly shows that by drilling a $\frac{1}{2}$-inch hole through the corner angle at *c*, and introducing two or three ounces of nitro-glycerine, the whole front of the safe could be blown out at one explosion, and the whole operation from start to finish could be easily made in 30 minutes. As nitro-glycerine will enter a crevice or opening $\frac{1}{1000}$ of an inch wide, and the "butt" joint of the plates at the corner shown in Fig. 1, is such as would result from placing the edges of rough-sheared boiler plates together as shown, and which would leave a passage way clear into the safe of practically $\frac{1}{32}$ to $\frac{1}{16}$ of an inch, the introduction of any liquid explosive would be mere child's play. This want of contact of the plates at the corners is assumed by the builder to be overcome, by a filling of thick paint, putty or other patch-work material. Results, however, show that a teaspoonful of nitro-glycerine clears this filling away like a gale of wind would blow away a handful of feathers. If it, therefore, became a question of opening a screw-door safe in the shortest possible time, with but *one* explosion, which might be heard one hundred feet away, the taking out of the whole front of a screw-door safe, as explained, would be the plan to follow, and such an operation can be performed in 30 minutes absolutely without noise, except the final explosion, which might be heard one hundred feet away.

But when silent "kid-glove work" (as Wm. Pinkerton, the great detective, characterized the opening of the screw-door safe, which he witnessed) is desired, the plan to be adopted is as follows: Fig. 1 shows the door of the safe in section. This door is made up of $\frac{1}{2}$-inch plates of Brooklyn chrome steel (welded steel and iron), except the outer plate, which is an inch thick. These plates are held together by countersunk screws, which in the outer plate run but half way through it. Thus the front of the safe presents an absolutely smooth surface, without a hole through the safe front or door itself, which is locked by an automatic time lock device, which, being all *inside* the safe, cannot be manipulated in any way from the outside, since there is no spindle, shaft, hole or opening of any kind through the door to the outside. The periphery of the door being ground into the body of the safe, and the outer surface of the door being flush and even with the body of the safe, there is absolutely no opportunity for the introduction of any explosive, solid or liquid, and yet the screw door safe is really the most easily opened safe in use, because its very construction necessitates only the taking off of plate after plate of the door, which is about 20 inches in diameter. Less than a teaspoonful of nitro-glycerine exploded behind each plate will remove it with less noise than a Flobert toy rifle makes in shooting a 22B. target shot, which is practically the same as the snap of a whip. The introduction of nitro-glycerine, therefore, behind the outer plate of the door *d*, Fig. 1, is the first thing to be accomplished. A basket of heavy netting (No. 10 wire) is wired onto the door of the safe, Fig. 2, in which *b* is the basket—roughly bent into shape—which is held in place by the wire *a*, or other convenient means.

In this basket, whose capacity may be equal to a quart and a half, is placed charcoal, which is ignited and urged to a fierce heat with the hand bellows *c* for five to eight minutes. This operation draws the temper of the chrome steel, or other laminated steel and iron, of which all plate safes and vaults are made, and anneals it. The basket is then removed, and with an ordinary breast drill a $\frac{3}{16}$-inch hole, *a*, Fig. 3, is drilled through the first plate. A well hole of putty shown in section at *b*, Fig. 3, and in perspective at *d*, Fig. 2, is then erected as shown in Fig. 3, so as to hold a small quantity of nitro-glycerine, and inclose the hole *a*, Fig. 3. A teaspoonful of nitro-glycerine is then poured into the well hole of putty, which, of course, flows through the hole *a*, Fig. 3. Ordinarily this will disappear in the crevice between the outer and next plate. But if it does not, it is exploded, which results in opening up a passage (a separation of the plates) between the outer and next plate, even if these plates be faced and ground together. The nitro-glycerine is exploded by placing an ordinary fulminate of mercury cap—such as can be purchased at any general country store, which keeps "rendrock," "forcite," etc., for farmers' use in blowing up stumps, etc.,—in the well hole. The cap should be placed so as to have actual contact with the small remaining quantity of explosive left in the well hole, actual contact being necessary. These caps are of two kinds—those intended to be exploded by a pocket battery, and those used by farmers, quarrymen, etc., known as "blasting caps," which have a time fuse to be ignited by a match. If the explosive does not readily disappear between the outer and next plate, and an explosion is necessary, as explained, to separate the plate slightly, and this explosion has been made, it will then be necessary to introduce the second charge of $\frac{1}{2}$ ounce, which, when exploded, will blow off the outer plate. This outer plate being held by screws to the next plate, the explosion breaks them off, and in doing so stretches them slightly, which reduces their diameter, and at the same time the second plate is sprung outward a little, as at *b*, Fig. 6, *a* being this second plate, and *c* the screw broken off by the tearing off of the first plate. These screws *c* can be pushed back by hand against the next plate, as shown in Fig. 6, as they will be found to be quite loose. As will be seen, a clear passage way

is left around each screw for the introduction of the explosive, which is introduced and exploded, as already described. The removal of this second plate, *b*, breaks off the screws connecting it with the next plate, *a*, which plate is sprung outward as described, and through the screw holes of which the next plate is taken off, and so on, until all the door plates are removed. The reproduction of the photographs are shown in Figs. 4 and 5, and show the safe before and after the operation. The time occupied was 2 hours and 57 minutes, and, burglariously speaking, no noise was made.

Of course it is understood that the cast-iron gear and housing on the outside of the door for operating it in legitimate use, are removed by a few blows of a small sledge hammer, so as to leave the door proper exposed to operate on as explained.

For experimental purposes the writer uses nitro-glycerine obtained from dynamite, because of the ease with which it may be done.

The government report on safe and vault construction indicates this method as follows, on page 66: "Take a cartridge of dynamite, and break it up into small pieces. Put these into a bottle of convenient size, and pour over it a quantity of 95 per cent. alcohol. Shake freely, and with a wooden stick break up the soaking dynamite into as small pieces as possible. The alcohol cuts the nitro-glycerine, and changes its color to a light yellow. The pulp is now filtered in another bottle, the residue is squeezed out, and the liquid from it is also filtered. Small portions of the filtered alcohol solution are poured into a bottle, and as much water as there is alcohol is added. Shake the bottle for a few minutes. Let it stand when the nitro-glycerine is precipitated to the bottom of the bottle. Pour off the water and alcohol, and then pour the nitro-glycerine into a convenient receptacle." H. F. G.

A Pair of Useful Arbors.

At one time I had occasion to turn some bicycle ball-bearings like *D* in Fig. 1, and found the method shown a most satisfactory one.

It will be seen that the steel piece *D* while requiring quite a large cut to form the

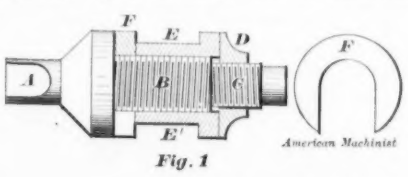


Fig. 1

curve, presents no available surface hold for removing from a screw arbor, and as it was to be finished on the circumference, end, and curve, all at once, it is easy to see how difficult it would be to remove it from an ordinary nut arbor after being tightened by the turning operation.

After some study the plan shown in the drawing was thought of and found to be a complete success.

The arbor *A* is provided with a left-hand threaded part at *B*, and a right-hand threaded part at *C*. The piece *D*, drop-forging or whatever it was, having been faced off and threaded, was run freely onto the right-hand thread *C*; while the left-hand thread part *B* was enough larger to allow the nut *E* to pass over *C*.

F was a gauge used to locate the work in the same place at each turning, and was dropped over *B* as shown, then the nut *E* was screwed up to it by hand, the nut running freely like *D*, which was then brought up against *E* in the same way.

When the turning tool caught the piece *D* with a good grip, then *D* and *E* hugged together sufficiently to allow *F* to be removed by hand, or to fall of its own weight. *E* was a case-hardened nut, milled off at *E E'* for a wrench. When the work was finished, *F* being out of the way, *E* was loosened with a wrench, and *D* removed by hand without being scratched.

By using the piece *F* as described the pieces *D* were gauged very accurately.

Being so well-pleased with the results of this I made another arbor upon the same

Fig. 2

principle for the milling machine as shown in Fig. 2.

This was made and used more especially for small punch and die work and proved equally satisfactory.

A stock of cutter blanks ¾ inch in diameter like *F* were made, and a number formed into general shapes—round, flat and angular for any job, and the others shaped as required for special use.

This proved to be a great improvement over anything I had ever used as an arbor for holding cutters on the end of same—far better than screwing cutters up to a shoulder or using pin with countersink and screw, and much stronger. The arbor, nuts and collars were all hardened or case-hardened.

The same arbor was used for turning and facing cutter blanks true, and is very convenient for backing of cutters in the vise, as the cutters can be turned readily by hand and tightened the same way with nut *B*.

B fits left-hand thread *D* freely, and has a good though not a tight fit at straight part *C*.

This makes the arbor stiff and supported by the shell *B*. *G* and *H* are collars.

Cutters run true, tighten themselves, and can be removed instantly without breaking the teeth by using wrench at *B*.

By using cutters of a uniform size, punches can be finished up in the lathe after-

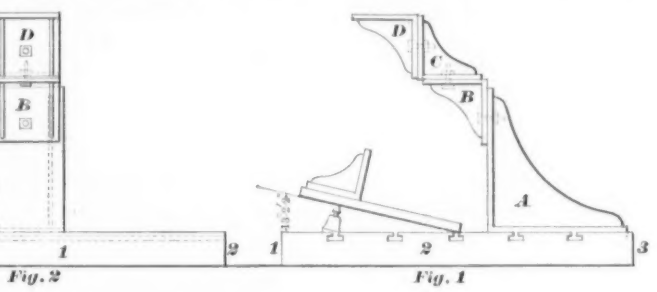


Fig. 2

Fig. 1

wards with rifflers or rotary files of the same diameter as the cutters. This is quite desirable where the punches are shaved in the die, and a fin and jog left on the stock in a bad place to reach with a file.

Then after being hardened the same surface can be polished quickly with emery wheels, narrow, and of ¾ inch diameter, or whatever is used for diameter of cutters. This leaves the punch bright for tempering.

A little method where practicable saves work and improves appearance as well.

Chicago, Ill. A. H. CLEAVES.

Laying Out Angular Work.

BY FRANK PIERS, M. E.

The drawing accompanying this article shows a piece which presents some difficulty in laying it out accurately. As angular pieces in general are difficult, it may prove interesting to the reader to have the method employed in this case described.

The body of the casting is a water pan carrying the parts marked *H*, *E*, *K* and *P*, and attached to the bed of the machine, of which it forms a part, by the foot *F*. The base of the corner pad *P* is parallel to the base of *F*, and the bottom of the pan is inclined at an angle of 5 degrees, as shown in No. 1 of the drawing.

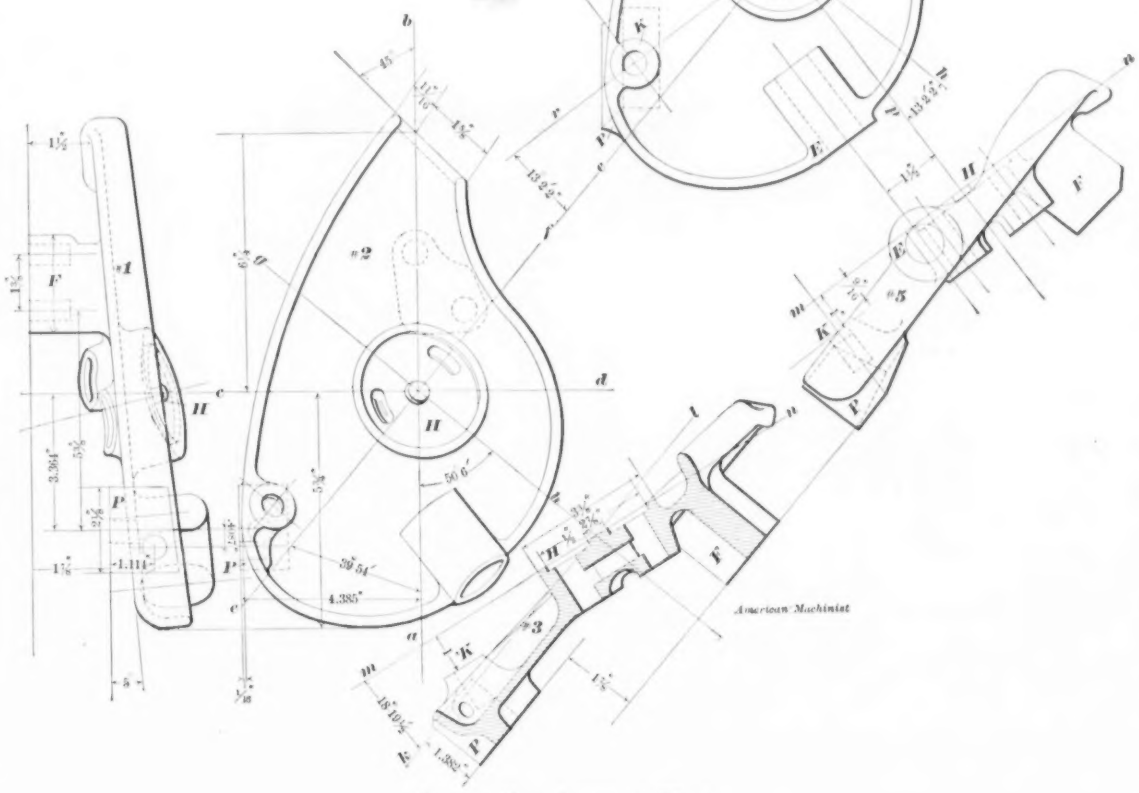
A piece of wood about 6 inches long by 4 inches wide, planed at 5 degrees and about 1 inch thick at the large end, was placed under the pan, after cutting away such parts as interfered with the projections, and a hole bored, so that a bolt might be passed through it and one of the cored holes in *H* for the purpose of bolting the pan and angle block to a knee.

Three 6-inch and one 16-inch knees were then bolted together, and the large one bolted to the laying-out table. See Figs. 1 and 2.

For convenience of description the sides of the table are numbered 1, 2, 3, 4, and the knees marked *A*, *B*, *C*, *D*.

The pan was bolted to the knee *D* with the foot *F* to the right-hand side, looking at it from side 1 of the table. The knee *B* was then turned to the right 90 degrees (that is, in the direction the hands of a watch move), and *C* turned 90 degrees to the left. Looking at this from side 2 of the table the casting will be seen as in No. 2 of the drawing with the corner pad *P* up, and the line *a b* parallel with the table. The point through which the line *a b* passes at the mouth of the pan was then marked off according to the drawing, and another point near the broad end of the pan, 4.385 inches from the finish line of *P* (which the drawing shows is $\frac{1}{16}$ inch from the edge of the pan). These points were then set by moving the pan, so that they were equally distant from the table. At the same time the sides of the 5-degree angle block were set parallel with the table, and the bolt tightened. The line *a b* was then drawn through the points found, and across *H*. After drawing the finish line on *P* the knee *C* was turned back 90 degrees to the right; then 6¼ inches above the intersection of *a b* with the mouth, or small end of the pan, the line *c d* was drawn.

If the surface of *H* was finished the intersection of *a b* and *c d* would mark its center, but as more or less metal is left on the casting for finishing, and *H* does not lie in a plane parallel with that in which the measurements are taken, there will be more or less error, according to the amount of finish; this, however, may be corrected, as will be seen further on.



LAYING OUT ANGULAR WORK.

Turning *B* back to the position shown in Fig. 2 the base lines were drawn on *F* and *P*, also the line *k l* (1.382 inches above the base of *P*) on the side of *H*, and a line drawn on both sides of the pan, to be used for setting it, to plane *F* and *P*. *B* was then turned to the right 90 degrees and *C* to the left 39 degrees 54 minutes. Looking at this from side 1 of the table, it will be seen as in No. 3 of the drawing. The point of the scriber was set at the intersection of *a b* and *c d*, and the line *g h* marked on the side of *H*, crossing *k l*. Turning *C* at 90 degrees to this position, *e f* was drawn through the intersection of *a b* and *c d* at right angles to *g h*. *C* was then turned back 90 degrees, bringing *g h* parallel with the table, and *B* turned to the left 18 degrees 19½ minutes.

This is seen from side 1 with the line *m n* perpendicular to the table. The point of the scriber was then set at the intersection of *k l* and *g h*, and a line drawn across the surface of *H*, its point of intersection with *e f* is the correct center of *H*.

A cast iron plate, finished all over, was then placed on the table, with one end raised so that its surface made an angle of 13 degrees, 2 minutes, 2 seconds with the table and squared from the face of the knee *A*. See Fig. 1.

Placing the scribe block on this plate with the point of the scriber 1½ inches above the center of *H* (see No. 4 and No. 5 of the drawing) a line was drawn across the center of *E*. Then 4½ inches above the center of *H* a line crossing the center of *K*. Then a knee was placed on the plate square with its edges and

the line *r s* drawn through the centers of *H* and *K*, using the knee as a base for the scribe block.

The plate and knee were then removed, and *B* turned 90 degrees to the left, bringing *m n* parallel with the table, the point of the scriber was set at the intersection of *g h* and *k l* and the line *m n* drawn, which marked the surface of *H*; $\frac{9}{16}$ inch below *m n* a line was drawn crossing the center of *E*; 1 inch below *m n*, a line marking the surface of *K*.

This completed the work with the exception of the bolt holes.

The knees were set at the proper angles with each other by applying a bevel gauge to the edges.

A Voice from India for the Standard Catalog.

We gladly help to spread a good word for a good work. We find the following in the *Indian Engineer:*

When traveling in America, on business connected with our firm a short while back, I was struck at the vast difference which existed between the catalogs and price lists which I carried, and those which I found current in that country. I was quite prepared to find a well-marked difference in the get-up and finish of the American price lists, compared with ours, and found it with a vengeance, too. American catalogs are, to my mind, almost the acme of what such lists should be. But it is not as regards the finish or get up that I wish to speak; it is the fact of their sizes being all to a certain fixed standard (6 inches by 9 inches), which makes them so much better than ours. The Americans, by adopting a standard size, have minimized the trouble and discomfort of handling a lot of such literature, and why should we not do the same and adopt a standard size also?

I have an idea that this letter will raise a smile on the features of many of your readers. Let me tell these good folk, that if they found themselves in the position I have often been in, when hunting for a small price list, in pamphlet form, to hand to a client, and conscious of the fact that there was but a very few minutes left to drive to the station for the last train, I feel sure the smile would give place to profanity. It is a vast pity that in India alone there is no association or society of engineers, and those engaged in the profession, in which such seemingly trivial, but really important, subjects could be discussed. Now, in America, every large manufacturing city has its society of engineers, and much good is derived thereby. Can nothing be done in this direction in India?

Bombay, 22d April, 1895. Yours faithfully, CHATTELS.

Long Terms of Employment.

The Economist, of Louisville, Ky., says that the firm of B. F. Avery & Sons have, employed at their plow works in that city, 88 employes whose combined terms of service aggregate 2,003 years, which is an average of nearly 23 years for each man. It is thought that few manufacturing concerns can show an equal record.

LETTERS FROM PRACTICAL MEN.

Compound Gas-Steam Engines.

Editor American Machinist:

Your editorial in your issue for April 25th, headed "The Gas Engine and the Steam Engine Joined," redirects attention to a consideration of the possible economy to be derived from the adoption of a combined gas and steam motor, which combination, from a purely thermodynamical standpoint, appears to offer a promising field for investigation. It is, however, a mistake to suppose that the general principle—that of utilizing the rejected heat from the gas engine jacket to heat the steam cylinder, and so prevent the very large losses due to cylinder condensation—is in any way novel. At the same time, it is fair to say that I do not recollect having previously seen suggested the precise arrangement proposed by the engineer of whom you make mention in your editorial. The problem resolves itself into the devising of the simplest and most practical method of causing the principal source of heat loss in the gas engine to neutralize the principal source of heat loss in the steam engine, but it is plain that whatever the arrangement may be, it will undoubtedly possess most of the defects of each type of motor. Right beyond the question of increased cost and complication of the engine itself, there is the fact to be borne carefully in mind that both a steam boiler and gas producer will be needed in all situations where a town's gas supply is not available. Putting on one side the fact that one of the great claims made for the gas engine is that it enables the boiler to be dispensed with, is it reasonable to suppose that the possible saving which *may* be effected in practice in plants of, say, from 30 to 300 I. H. P. will pay for the increased capital outlay?

Reverting to the actual attempts which have been made to carry the suggested combination to a practical issue, I may refer to the engine made by a Mr. Chatterton, of London, who about the end of 1891 drew attention to the subject. In Chatterton's engine the gas and steam were used successively in the same cylinder, but were carefully prevented from mixing with each other. In this case it was considered that the 40 per cent. of the heat of combustion which ordinarily passed to waste through the cylinder walls of the gas engine, would be utilized to heat the metal of the cylinder, and would be given up to the steam entering the cylinder during the next outward stroke, superheating it, or at least effectually preventing "initial condensation." The inventor anticipated that with his dual motor he would be able to obtain an economy corresponding to 1.25 pounds of fuel per I. H. P., and thus effect a saving of about 50 per cent. over the ordinary steam engines used for power of less than 300 I. H. P. Of course other benefits were to be derived from the use of the combined engine, as compared with the gas engine. Thus much greater uniformity in speed and steadiness in turning would be obtained, and that grave defect in the gas engine—difficulty of starting—would be entirely obviated.

I am sorry that I can give no further information respecting the Chatterton engine. Like many another theoretically "beautiful" idea, but little was heard of it after the initial "booming." The same may be said with regard to the still earlier suggestion of M. Ch. Tellier, who in 1889 read a paper before the French Academy of Sciences, in which he described a gas-steam motor still more complicated in arrangement. The inventor, in this case, not only used gas and steam, but also the vapor of ammonia, as a third source of motive power. The explosion of the combustible gas was to be used to generate steam and vapor of ammonia, and all three were successively used in the engine, but not in the same cylinder. The complete motor consisted of two cylinders, in one of which vapor of ammonia only was employed for both outward and inward strokes. In the other cylinder gas was used, and escaping at a temperature of about 400 degrees into a generator where steam is produced, which is used to act upon the opposite side of the piston. It is of interest to note that among the advantages claimed it is specified that "the high temperature due to the combustion of the gas prevents cylinder condensation, while the steam used in the return stroke assists the lubrication of the cylinder." The "practical economy" claimed for this arrangement was 0.44 pound of coal per I. H. P. per hour.

In the general discussion on the gas engine at the monthly meeting of the A. S. M. E., reference was made to the unenviable reputation which gas engines had obtained in the matter of speed regulation. Much, however, has been done recently towards minimizing this defect, and in the latest gas-driven central station in Ireland, viz., the Belfast electric installation, the double cylinder tandem gas engines do not appear to give any trouble on this score. There can be no doubt that the gas engine is, in Europe largely displacing the steam engine for small powers, while the oil engine, rapidly growing in public favor, seems likely to assist in making things worse for the makers of small engines and boilers. In France and Germany, gas engines of larger sizes, up to 500 I. H. P., do not now seem to be regarded with disfavor, and there is every reason to expect further developments in this direction, probably obtained, however, by the use of more cylinders, rather than by increasing the dimensions of the cylinders as sometimes proposed.

M. E.

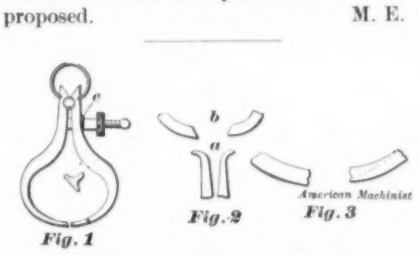


Fig. 1 Fig. 2 Fig. 3

Spring vs. Riveted Calipers.

Editor American Machinist:

As a practical machinist I am interested in the discussion of the relative merits of spring and riveted calipers, and think that there are good points in both kinds, and that each has an equal right to a place in the shop. I use spring calipers almost exclusively for sizes up to three or four inches diameter, but do not by any means think that for some phases of calipering even on these smaller sizes riveted calipers would not do just as well. For instance, when turning work in lathe to same size as piece already turned, or when turning to plug gauge, riveted calipers are all right, and can be easily set, if made right, by simply forcing them over the work a few times a little out of true. But in other phases of calipering they do not work so well, as in setting to inside calipers or to size on scale for rough work. In these cases spring calipers are best to my notion, chiefly because of the greater ease with which they are set or adjusted. I can hardly agree with "A Mechanic" that one point in calipering is worth ten in setting. When accuracy is imperative such statement may be true, but how about repair work in a job shop? If it is true there also, then it would pay to use riveted calipers even though it took ten times as long to set them, and would the work be tenfold more accurate? And what is more to the point, would it *need* be ten times more accurate than spring calipers would make it?

This difficulty in setting quickly is, I think, the chief drawback to the general usefulness of riveted calipers and tends rather to throw in the shade their other good qualities. 'Tis true, "A Mechanic" informs us, that there are other ways of adjusting riveted calipers, besides striking them on the shop furniture (that process so apt to give a fellow "that tired feeling"), but I know of only two or three. One is the right and left-hand screw, and one the small spring and sliding arc, same as carpenters' dividers. Both of these are objectionable, the first from liability to thread wear, and the other because of lightness of spring for duty required of it. The third is somewhat better, but even it makes the tool look bunglesome, and is not nearly so easily handled as is the common nut and screw of spring calipers. But if some of these devices *are* good why do we not oftener see them attached? Hardly one pair in six that I have ever seen had any provision for adjusting, save the rapping, or tapping, or striking (whatever you are pleased to call it) process, and in most cases, especially in the larger sizes, I think they were better off without any.

On the other hand, spring calipers are by no means perfect. In fact, I have never yet seen a pair of spring calipers that exactly suited me in shape. The sketch accompanying Mr. Carter's article shows a style of caliper in general use, and is a fairly good tool, but it lacks rigidity most woefully to my notion from the screw about two-thirds of the way to the points. And this is a common fault with all spring calipers, along with two other faults, viz., making the points too heavy and blunt, and the screw of too coarse a pitch.

Fig. 1 in the sketch shows something of my idea of what a spring caliper should be—more metal in the middle and the legs and not so much at the points. What good anyhow, in the name of all that's mechanical, does that extra metal do on the points of calipers? It cannot be for stiffness, as every mechanic knows that of all places on the tool that is the one least liable to springiness or deflection owing to its form, and also because of the distance it is from the screw or fulcrum. I used to have a pair of Stevens' spring calipers (and of quite recent style too) with points exactly as shown at Fig. 3. When I wanted to take size off another pair of calipers, I had to hunt around on those two great surfaces of metal for the highest point like a phrenologist feeling for bumps on a fellow's head, and after I had found it was never dead sure about it. The broken line shows the part I would have had sliced off by this time had I not lost them.

If I could materialize Fig. 1, I would have the points tapered down quite small, as shown, round on the ends and case-hardened; the screw about twice as large in diameter as in common practice, hollow if need be to lighten it, and about twice as many threads to the inch as ordinary, say, 64 or thereabouts. I would also have ball bearing at *e* if possible, or at least some device to get rid of that catchy, jerky motion which we are apt to find in caliper nuts when attempting fine adjustment. The cross-section would be somewhat like that shown—about the same area, but a little differently distributed. With such calipers I believe any ordinary machinist could do good work.

Fig. 2 at *a* represents the points of a pair of inside calipers which I use nearly every day, and they work well. The points used to look something like the outside ones at *b* in the same figure, but I worked them over into their present form. Those at *b* are the kind generally found on spring calipers, but I do not like them. Coming to a sharp edge as they do with angle-end faces does not work so bad on small diameters, but when the work is large enough to bring those end faces parallel with each other, it is difficult to find the bearing point.

To sum up, I think it would be found on investigation that spring calipers are handier, riveted ones truer; that but few "lightning" machinists use riveted calipers, that machinists who have never done work truer than spring calipers will make it are not of the best, and that very much in connection with all calipers depends on the man who uses them.

A. K. A.

Electricity Generated by a Steam Jet.

Editor American Machinist:

When electric sparks are evolved and manifested, together with steam issuing from the safety valve of a boiler during the ordinary working operations of the engines supplied therefrom, and with an abundance of water in the boiler, with safety valve operating at a gauge pressure of 70 pounds per square inch, is such electricity generated at the moment and point of emission, or prior thereto, *within* the boiler? If the latter, what is the cause and precise point of generation under the conditions above noted, and what its probable effects, ordinary or extraordinary, first, on the water and steam within its scope, and secondly, on the substance and operation of the boiler itself, and possibly even on the engines operated therefrom, tending to cause injury thereto?

Is it possible, or reasonably probable, that, particularly when any part of the boiler directly subjected to the heated gases of the furnace, having become denuded of water, the *steam* in immediate contact with such part being insufficient to prevent its becoming unduly heated, becomes decomposed into its constituent elements, and electricity is evolved, as in an ordinary chemical electric battery, the boiler being such, in fact, for the time being, causing recomposition of

water again from its separated elements, and a more or less disastrous rupture of the boiler in many cases? J. W. PAYLER.

[It is understood that the electricity is generated by the friction of the steam at the point where it escapes, and there is no probability that there is any action in the boiler analogous to that of the chemical battery. In experiments conducted more than fifty years ago with an insulated boiler, it was found that the boiler became negatively charged while the steam was positive. An escape pipe was made terminating in a series of outlets shaped to impede the escape of the steam. The jets were lined with hard wood and led through a box filled with cold water, partially condensing the steam, which latter operation was found to be essential to its action, dry steam producing no excitation. A collecting comb held against the jet would charge any connected surface. By changing the material lining the jets, or by adding turpentine, the sign of the electricity was reversed. If the water contained acid or salts no electricity was produced. It is said that Faraday obtained similar results with currents of moist air. Some of our readers may be able to give us additional information in this line.—ED.]

Removing a Crank Pin.

Editor American Machinist:

In reference to taking out crank pins and shafts, by Mr. Bollinckx, the writer has used that method for years, and it refers to wrought-iron cranks, or solid cast crank, and should not be used on a cast web disk crank, for it will crack it by unequal expansion. The reverse is true for a slight misfit in pin or shaft. By heating the misfit member to a dull red heat, and plunging it in water, it will expand, as all hammered wrought-iron or steel will, and may then be shrunk in place. The latter has caused many a young man to leave the shop at night with a light heart, to my knowledge.

HALE G. ROBINSON.

Sending Catalogs to Technical Schools.

Editor American Machinist:

We notice that C. R. Richards, of the University of Nebraska, asks: "If manufacturers realize the importance of sending catalogs to technical schools," and further says he thinks they should send them without being asked. That manufacturers do realize the benefit to them would seem to be apparent from the fact that Mr. Richards says they always seem glad to send them when asked to do so, and we believe that were there a list of the schools and their location readily obtainable, the catalogs would be sent without waiting for the request, but if there is such a list to be had, we do not know where to look for it, and while we are not only willing but anxious to place our catalog in such schools, we have no means of doing so, only when we are requested to, and it certainly is a small matter for anyone desiring a copy of our catalog to send us a postal card asking for it, and it will be cheerfully furnished.

Athol, Mass. STANDARD TOOL CO.,
Per L. H. SAWIN.

Editor American Machinist:

We were interested in the letter written by C. R. Richards, of the University of Nebraska, in the May 23d number, in reference to importance of sending catalogs to technical schools. When our "Book of Tools" was brought out in January, we made considerable of an effort to obtain a list of the addresses of all technical schools, but without success. If Mr. Richards will kindly supply us with such a list we will be more than glad to send catalogs to the schools. The first edition (14,000 copies) is about exhausted, but we have a new edition of 24,000 on the press, which we expect to have out before long.

CHAS. A. STRELINGER & CO.
Detroit, Mich.

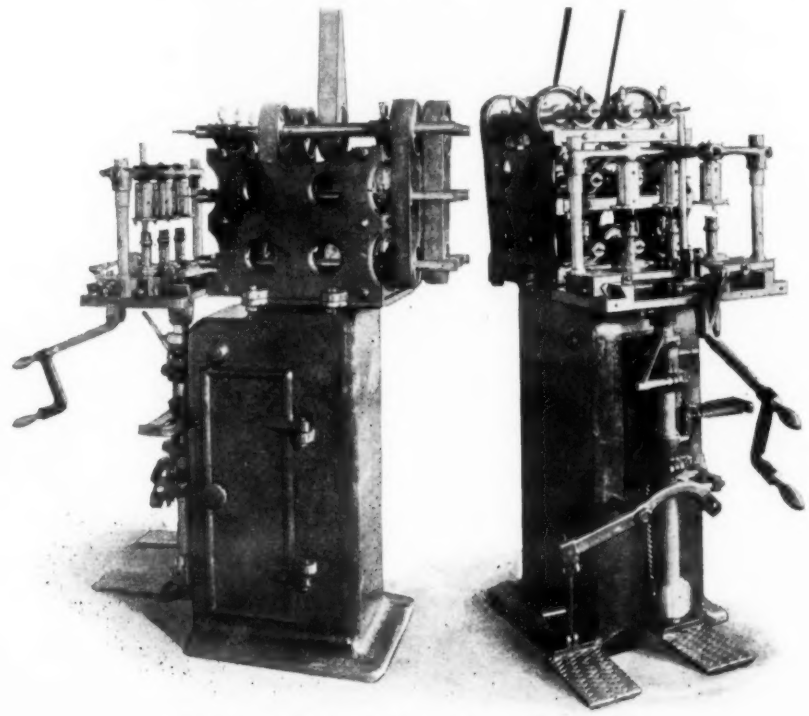
It is announced that the proposed international exhibition at Montreal, which was to have been held next year, has been given up.

Special Drilling Machine for Injector Work.

We present herewith engravings giving two views of a special drilling machine designed and built by Mr. W. A. Downes, superintendent of the shops of the Penberthy Injector Co., the machine being intended especially for use in manufacturing injectors in the shops of the company named, at Detroit.

There are nine horizontal spindles, three in each row, the middle spindle being belted and driven by a countershaft above, the other eight by belts from this one. On the end of each spindle is a drill chuck with a split bushing to accommodate any required size drill used for the work being done. The large vertical shaft below that carries platen, jigs, and work to be drilled, is kept in line by a key fixed firmly in column. The platen itself is keyed to vertical shaft to keep it square with points of drills, and is also held firmly to place by set screws.

The part of machine that carries bottom half of jig is gibbed to lower platen and has a horizontal movement, actuated by a hand lever. To the bottom of jig carrier are fixed three 4-inch gear wheels, which revolve each jig at the proper moment automatically. On the middle one is an index which engages with a dog fixed to lower platen. This serves to hold the work in line while being drilled. There is also a peculiarly constructed dog that engages with pin in index plate on the return of jig carrier after



SPECIAL DRILLING MACHINE FOR INJECTORS.

first holes are drilled, which revolves the work in line with next holes to be drilled. The top parts of jigs are carried by a cross bar which is guided to position by the two upright posts shown at either end of jig carrier. The middle post has a hole near its top which receives a pin and holds cross bar up while work is being renewed, and another further down a proper distance to hold the work in place. The small bar on top of the cross bar enters the slot at the proper moment to prevent the jigs from leaving their position, while the operator renews the work. The top of jig that enters the cross bar is counterbored to receive a spring which lifts the small bar out of the slot when the cross bar is down in position for drilling, thereby allowing the jig to be revolved freely. The foot treadle of the vertical shaft is to assist in lowering the work to the second row of drills when operations are begun at the top row of drills. The treadle to the left is to release the pin from the vertical shaft when changing from one position to another.

In operation three pieces of work are placed in the bottom half of the jig and the top cross bar is brought down to position. The pin entering the hole in middle post holds the jigs in place. The operator grasping the lever moves the platen forward until the drill point is through the jig and reverses back to stop. The gears underneath the platen revolve the jigs; another forward movement and the second hole is drilled; an easy lift of platen (which is counterbalanced) then brings the work up to the second row of drills. The platen is then returned to the stop. The 12 holes to be drilled vary in size from No. 55 Morse to $\frac{5}{16}$ inch diameter.

The Northrop Loom.

This loom seems to be worthy to take a place among the great and epoch-marking inventions. While cotton machinery as a class has been more than doubled in efficiency within a generation, little has been done toward the improvement of the loom itself, and yet it would seem to be a very inviting, if not a very promising field to the inventor. There are many hand operations necessary in connection with the operating of the loom. The shuttle carries a limited amount of filling, and as often as it is emptied it must be filled again. If the loom could automatically supply its own filling, and not keep the operator trotting to help it, much time would be saved. Mr. James H. Northrop has accomplished the apparent impossibility of putting a bobbin or cop of filling into a shuttle, ejecting the spent filling carrier, and threading the new weft into the eye of the shuttle, all being done without slowing the loom, the shuttle meanwhile having an intermittent motion of about two hundred flights per minute, traveling at a speed of over 12 feet per second.

The improved loom carries a supply of 14 filled bobbins in a hopper so that the weaver is relieved of 13 or more journeys to the loom, and he is also relieved from the health-destroying act of sucking the filling through the eye of the shuttle, an operation formerly performed about 200,000 times per year by each operator, making weavers as a class notoriously short lived and consumptive.

The Northrop loom as completed embodies several other devices than that above mentioned, and several other inventors have co-operated in perfecting it. The apparatus combines devices that permit the shuttle to vary in position and yet prevent any damage, if it is abnormally misplaced. The loom stops automatically when the hopper is exhausted, or if the shuttle is clogged and cannot be threaded, and it also stops if a warp thread breaks.

The principal features of the new mechanism are the shuttle, the transferrer, the hopper and the filling fork. The shuttle has an open bottom and holds the bobbin by means of spring jaws acting on large metal rings attached to the bobbin base. When a new bobbin is put in it crowds the spent one out, the latter falling through the bottom of the shuttle onto a guide which delivers it into a box. The shuttle has an incline and several notches in the springs so arranged as to permit a bobbin to be put in when the shuttle may be in various positions, according to the wear of the picker, its rebound, etc. The threading eye of the shuttle is slotted to permit the thread to enter it, the action of threading being automatic, and the motion of the shuttle guiding the thread into position. The filling must be supplied whenever the filling in the shuttle is broken or exhausted, and to detect the proper time an improved filling fork is employed. When the fork is not raised by the thread, a turning of a rod frees mechanism that inserts a new supply of filling. The bobbins of filling are held in a circular hopper, and the rotation of the hopper delivers each in turn into its proper position. The lay on each alternate forward stroke brings the shuttle directly under the hopper, where a movement of the transferrer or pusher effects the desired operation when necessary. This transferrer is pivoted and receives its rotating movement by a direct blow from a bunter on the lay, and the motion is therefore positive, and not dependent upon a spring or weight.

The operator places the bobbins in the hopper by hand, winding the end of the filling around a stud, the 14 being inserted in a minute and a half. Bobbins that are partly woven off can be put in as well as full ones. If the shuttle fails to thread twice in succession the loom stops.

While the operations mentioned above would need quite a long description, they are said to be quite simple in detail. The usual loom is not interfered with beyond a connection to the filling fork, and a cutting out of the lay plate and lay at the end where the spent bobbin is ejected. All the other parts are contained in the hopper, which is attached to the breast beam. Mechanically speaking, there is no reason why these devices cannot be attached to any loom now in operation. It is expected ultimately that the invention can be used upon every kind of weaving where a single shuttle is used. The Northrop loom is built by Geo. Draper & Sons, Hopedale, Mass.

The Steam and the Gas Engine Operated Together.

The editor of the AMERICAN MACHINIST has been conferring with "a prominent engineer," who says that a difficulty with a steam engine is to keep the cylinder hot, and, with a gas engine, to keep it cool. He therefore proposes to combine the two—the gas-engine cylinder to heat that of the steam engine, and the latter to cool the former. This recalls the scheme of an embryo civil engineer who observed that the top member of a suspension bridge was in tension, and that of a bow-string girder in compression. He therefore proposed a combination of the two principles, whereby the strains on the top member of the one would neutralize those on the other, and thus both could be dispensed with, and he would have a bridge with a lower chord alone. *That* bridge has never been built. How would it do to mix the exploded gases with the steam between the high and low-pressure cylinders of a compound engine?—*The American Engineer and R. R. Journal.*

That bridge story considered by itself is very good; but, "like the flowers that bloom in the spring, it has nothing to do with the case."

It cannot fairly be inferred from what we said that anyone proposed to "combine the two" cylinders, in order that a transfer of heat might take place between them; and nothing of the kind was meant. Upon rereading the item it will be found that what was proposed was that heat which is thrown away by the gas engine in two ways, *i. e.*, by its necessary jacket water and by its exhaust, should be transferred to and used by a steam engine forming part of the same power plant.

We have received several communications, in which it is claimed that this has been tried, but it is evident from the descriptions accompanying them that the experiment really tried was something else essentially different. Perhaps by straining its top member a little more, our contemporary can point out just where the thermodynamical error of the proposed plan comes in, and this would be instructive, because the fallacy involved in the matter is perhaps not quite so readily perceptible as might be supposed, granting, for the sake of argument, that there is such a fallacy.

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Some Interesting Statistics of Power.

The famous statistician, Michael G. Mulhall, has an article in the current *North American Review* which will naturally attract considerable attention here, since it is devoted to a study and analysis of the forces and influences which have placed this nation in the lead respecting those elements which go to make a really great nation. We have not space to notice more than a few of the points brought out, but it is especially interesting to note his statements regarding the power used in various countries and per inhabitant.

Mr. Mulhall places the working power of an able-bodied man at 300 foot-tons daily; of a horse 3,000, and of each horse-power of steam engines 4,000 foot-tons daily.

We suppose this last means the work actually done per nominal or maximum horse-power capacity, because each actual horse-power developed equals 9,000 foot-tons per day of 10 hours, reckoning a ton at 2,200 pounds, as Mr. Mulhall probably does.

Upon this basis he gives a table showing the millions of foot-tons of work performed in the service of the people of this country at different periods, as follows:

	Millions of foot-tons daily				Foot tons daily per
Year.	Hand.	Horse.	Steam.	Total.	inhab.
1820	753	3,360	240	4,293	446
1840.....	1,406	12,900	3,040	17,346	1,020
1860.....	2,805	22,200	14,000	39,005	1,240
1880.....	4,450	36,600	36,340	77,390	1,545
1895.....	6,406	55,200	67,700	129,306	1,940

The last column is especially significant, showing as it does that our increase of work done has been more rapid than our increase of population, being, in fact, nearly twice as great per inhabitant at present as in 1840. Steam power has, as we should expect, increased much faster than any other form of power.

Another table shows the relative standing of the leading nations with respect to power developed, and is as follows:

	Millions of foot-tons daily.				Foot-tons per
	Hand.	Horse.	Steam.	Total.	inhab.
U. S.....	6,406	55,200	67,700	129,306	1,940
Gr. Brit...	3,210	6,100	46,800	56,110	1,470
Germany..	4,280	11,500	29,800	45,580	902
France....	3,380	9,600	21,600	34,580	910
Austria ..	3,410	9,900	9,200	22,510	560
Italy....	2,570	4,020	4,800	11,390	380
Spain.....	1,540	5,500	3,600	10,640	590

A number of interesting things are shown by this table, but the most significant perhaps is the daily foot-tons of energy expended per inhabitant, as set forth in the last column, where it is shown that each person in America has 32 per cent. more power in his service than in Great Britain; 115 per cent. more than in Germany; 113 per cent. more than in France; 246 per cent. more than in Austria; 411 per cent. more than in Italy, and 230 per cent. more than in Spain.

Speaking of labor-saving machinery, Mr. Mulhall refers to the reaping machine used in the Western States, which "will cut and bind grain at the rate of forty-five minutes per acre," and he figures that an ordinary farm hand in this country raises as much grain as three hands do in England, four in France, five in Germany, and six in Austria.

It has been shown something like this ratio of production exists in some industrial lines also, especially in those in which American machinery and systems of manufacturing have been fully utilized.

The showing respecting education is also very flattering, as it appears we spend much more money per inhabitant for education and have a larger number of instructed people than any other nation.

The Advertiser and the Advertisee.

There is in life no mistake more common than in the estimate of the disinterested witness as compared with the active partisan. Nothing is more common than to immediately reject any and all *ex parte* evidence as worthless or worse. Now there may be two sides to every question until it is settled, but after that there is only one side. No question is ever finally settled until all has been said that can be said both for and against it, so that things are always settled not by disinterested and presumably honest testimony, but by *ex parte* testimony almost exclusively. The disinterested party is of little account anywhere. Say that he will tell the truth without favor to either side. What help is there in that when he has not the truth to tell, and if he had it he lacks the stimulus that even truth-telling needs if it is to be told in its fullness and with force. There must be the incentive of active interest and the promise of personal advantage urging to the discovery of facts and methods and of so presenting them that they shall find acceptance. In the unceasing conflict between man and the forces of nature, little advance is ever made except by him who strives to the uttermost and whose powers are sharply spurred and all absorbed in the task in hand. The impartial and the disinterested schoolmen are never in the front where the disputed steps of vantage are won. They have always been, and may well be, the historians of the conflict, the geographers of the conquered territory, the adjudicators of the accomplished fact, but they are not the makers of the history, they do not furnish the evidence that decides the controversy. Business is always a matter of question and strife. It is advanced by selfishness and partisanship. Indifference and disinterest have no business in business. The advertisers and the advertisees; those who have something to say and who take pains to say it most effectively are the winning partisans upon the one side, and they who are keenly alert for the latest in means and methods are the winners upon the other side. They are nothing if not partisans, but none has a better right to be than they or a stronger assurance of continuance.

Our Present Ignorance of the Steam Engine.

An editorial in *The Engineer*, London, embodying a flattering notice of Professor Unwin's lecture upon "Heat Engines," which still practically mean the steam engine, makes it appear that after all the steam engine problem is more puzzling and farther from solution than ever before. We take the liberty of reproducing the substance of the article referred to for the interest of our readers. Attention is called in detail to two or three of the puzzles of the modern steam engine. Rapid cut-off and small clearance count for economy; steam engine efficiency depends mainly upon the difference between the initial and terminal temperatures within it; but we may have the same range with a slow and with a quick cut-off, the same weight of steam being used per stroke, yet with the quick cut-off the engine will be more economical than with the slow. It is not an answer to say that the expansion is more complete in the one case than in the other. The difference between the diagram from a Corliss engine and a good slide-valve engine is very slight, and apparently all at the cut-off point, and this little difference does not explain the saving in weight of steam used. No explanation to account for the virtues of the quick cut-off is satisfactory, many successful engineers will not admit the value of the lightning cut-off, and some very economical engines are without it. The Leavitt pumping engines have slide valves worked by cams.

In the matter of clearance, we seem to encounter remarkable contradictions. The steam in filling the clearance space does no work, and loses neither heat nor energy. Though virtual expansion is reduced that accounts for little, the ratio of expansion may be what we please, while the clearance varies within wide limits. With an expansion engine without clearance taking in one pound of steam per stroke, we get a certain result. If the engine be given 15 per cent. clearance then it will take 1.15 of steam per stroke, but the whole body of steam will expand and do work and the loss cannot be anything like 15 per cent., but in practice it is very probable that an engine with a clearance of 15 per cent. would be more than 15 per cent. worse than an engine with 2.5 or 3 per cent. of clearance. Nobody knows why. Then although clearance is so fatal in a single cylinder engine, or in the high-pressure cylinder of a compound engine, it is not a source of waste worth mentioning in the intermediate and low-pressure cylinders which have enormous clearances and a falling pressure for the whole stroke. We hear about the loss by "drop," but nobody remarks upon the fact that the receiver is a mere extension of the cylinder all the time that the steam valve is open.

The jacket question is no clearer than the others. Professor Unwin says: "Roughly the jacket is more useful with small engines than with large, with slow engines than with fast; but all this amounts to little more than that the jacket is most useful where initial condensation is largest. Just in proportion as the engine is of the highest class and of most scientific design, so the jacket is less useful." The only use, or certainly the principal use, of the jacket is to prevent cylinder condensation. The only way in which a jacket can be of use is in keeping the cylinder hot. Why should it be less needed for this purpose when the clearance is small and the cut-off sharp, and the range of cylinder temperature considerable, than it is when these conditions, all favoring cylinder condensation, are not present? The only radical difference between a good and a bad engine in the use of steam is that the former will work with small clearance, high expansion and quick cut-off; how can it be possible to show that in such an engine the initial condensation is so small that a jacket can do no good? Notwithstanding the labors of Hirn, Zenner, Dongin and many others, next to nothing is known of what takes place in an engine cylinder. "The fact that meets us at every turn is, that no two engines—however apparently alike—behave in the same way, and this being the case it seems to be impossible to lay down any law—graphically or otherwise—which can have a general, or nearly general, application."

It is sad to find so eminent an authority making a confession so humiliating as to the state of our knowledge of the steam engine. Nevertheless while stumbling ignorance continues to improve it we may hope yet to find the secret of the success.

To us, apparently, the most prolific source of perplexity in the study of the steam engine is that so few isolated experiments are possible. The effects of any change can seldom be studied as absolutely independent of every other change. It is seldom possible even to compare the effect of sharp cut-off with that of slow closure without being involved in other complications. The mechanism that accomplishes the quick cut-off is usually part of a series that gives essentially different valve movements at other vital points of the stroke.

The evidence of the indicator and its diagram as to the complete cycle of operations in the steam cylinder is not all that could be desired, and it is a wonder that it has so long been so complacently accepted. For certain observations, either the movement of the indicator drum should be changed, or the present indicator should be supplemented by another and very different apparatus. As it is now the indicator is either motionless or is moving at its slowest at the ends of the engine stroke where the steam transitions mostly occur, and what report it vouchsafes us of those transitions is never as clear and indisputable as it should be.

Literary Notes.

DIE MASCHINELLEN HILFSMITTEL DER CHEMISCHEN TECHNIK. By A. Parnicke, Civil Engineer.

This book, written in the German language, treats on machinery and mechanical appliances, and means used in various industrial pursuits, and adapted to special purposes, particularly those in which the chemist is interested. The source of power is considered, including descriptions and illustrations of the various types of boilers, and remarks relating to their management. The various modes of transmission of power receive their share of attention; and economical handling of products is treated and

accompanied by descriptions and illustrations of different kinds of elevators, cranes, etc., and the various means and apparatus for conducting liquids and gases.

The character of the book is descriptive and practical, mathematical problems being entirely omitted. The novice will find much useful information in this book, and professional men may also find much of interest to them, as it covers a wide field of mechanical engineering. For want of space the different subjects are treated in a very brief manner. The illustrations are very good and show machinery and appliances up to date. The book is published by H. Bechhold, Frankfurt, A. M., Germany. Price, 10 marks.

Locomotive Engineering for June is a great paper. It has 100 pages including the covers, is filled with matter interesting to railroad men, and is accompanied with a transparent engraving of a modern railway coach with all parts numbered and their names given on the margin, making it a reference for technical terms.

It would seem as though the launching of new technical journals of various kinds would soon come to be classed as one of the great American industries, a great many new ones having been started within the past few months. The latest and newest is called *Engine and Boiler Room*, and is published at 226 La Salle street, Chicago, Ill. As its name indicates, it is devoted exclusively to matters connected with steam plants, and the first number contains illustrations of a slow-speed centrifugal pump, boiler setting, an article on the "New Theory of Injectors," and a directory of engineering societies.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(239) ——, Bologne, Italy: We do not understand your question. Kindly write it plainly and, if possible, in English; we will then take pleasure in answering it.

(240) C. P. B., Columbus, Ohio, writes: Kindly give me the name of the firm which manufactures oil motors for carriages or tricycles. *A.*—Northrop Manufacturing Co., Camden, N. J.

(241) Enquirer, Springfield, Mass., writes: In speaking of a crank shaft, is this term understood to mean the shaft, the crank and the pin complete, or does it apply only to the shaft itself? *A.*—Generally, the term crank shaft means the shaft, crank disk and crank pin, but not the fly-wheel or pulleys. 2. Which do you consider the proper expression, to say that the crank disks are "keyed *to* the shaft" or "keyed *on* the shaft"? *A.*—We do not consider ourselves an authority on such a matter, but think that either form is about equally correct.

(242) W. N. R., La Porte, Ind., writes: I would like to know how many grades, or numbers, of Parson's white brass are used by marine engine builders. Please give the proportions of tin, zinc, etc., used in the mixture of the several numbers. *A.*—Parson's white brass, No. 2 quality, is used by marine engine builders for facing and lining bearings; its composition is: Tin, 68; zinc, 30.5; copper, 1, and lead, 0.5. Another composition is: Tin, 68; antimony, 1; lead, 2; copper, 2; zinc, 27. These are the only two grades of Parson's white brass that we know of.

(243) A. T. O., Waltham, Mass., writes: Please inform me in which issues the articles on "Modern Locomotive Construction" were commenced and completed. Also give date of issue of these articles in which the locomotive is completely illustrated. *A.*—These articles were commenced in our issue June 27, 1885, and completed in the issue of December 12, 1889. A complete illustration of the locomotive has not been shown in these articles, but several of them will be found in the book in which these articles have been published. In regard to the naval architectural college which you mention, we cannot give any information in regard to it, possibly it is a private institution, we have not heard of it before.

(244) G. F. B., ——, writes: A controversy has arisen in our shop concerning the operation of engines when coupled in pairs, and we have decided to leave the matter to you. If a pair of stationary engines of, say, 20 horse-power be coupled together with their crank pins quartering as in a locomotive, will they not in operation exert the full power of both, or in the supposed case, 40 horse-power? Will they not exert the same power if connected quartering as they would if connected with the crank pins opposite? *A.*—The two engines coupled together will, of course, develop as much indicated power as they would if worked singly, and the difference in brake power would be only that due to differences in frictional resistance, which would be small, and as liable to favor one arrangement as the other probably.

(245) C. A. M., Boston, Mass., writes: In a system of piping for steam heating I find a condition of affairs as follows: The direct steam and return pipes are connected between the boiler and last radiator in the system which is placed about level with the trap. What I would like to know is, will this work? Will not the live steam entering the return pipe prevent the water of condensation from returning to the boiler, and will it work as a low-pressure heating system as well as high, if it works at all? *A.*—The connection between the steam and return pipes will not prevent the return of water into the boiler. The addition of this connection will not affect injuriously the action of a high nor low pressure heating system; but under some conditions will prevent water hammer and noise. Another point in favor of this connection is, it prevents water, which is required in the boiler, from "backing up" into the lines when the heaters are shut off. The want of this water in sectional boilers, or boilers of small water capacity, may be a serious matter. If the system is otherwise properly fitted up we see no reason for a failure in its action.

(246) W. C., Stapleton, N. Y., writes: I notice in answer to Question 225, in your issue of May 30th, current volume, a slight error which, however, very materially affects the solution of the problem. The head in feet corresponding to a pressure of 100 pounds per square inch is $2.304 \times 100 = 230.4$ feet (not 23.04 feet), which gives a velocity of 58 feet per second, and a discharge consequently more than three times as great as you give. *A.*—We thank our correspondent and three others who have written to us on the same subject for drawing our attent.on to the error of misplacing the decimal point in finding the head due to the given pressure, which should have been 230.4 feet in place of 23.04 feet. This, according to formula (1) in answer to Question 225, gives a velocity of 58 feet per minute. Multiplying this velocity by the area of the pipe in square feet, we have $58 \times .049 = 2.842$ cubic feet discharged per second, or $2.842 \times 60 = 170.52$ cubic feet per minute; multiplying the number of cubic feet discharged by 7.481, we have $170.52 \times 7.481 = 1,275.16$ gallons discharged per minute.

(247) S. E. W., East Grove, Ill., writes: In your issue of April 30, 1891, you give an illustration of a triple-expansion engine built in Italy for the Italian steamship "Sirio." The diameters of the three cylinders are as follows: High-pressure cylinder, 37 inches; intermediate, 61; and low-pressure cylinder, 98½ inches. The effective area of the high-pressure cylinder is to the effective area of the intermediate as 1 is to 3, very nearly. According to this, the cut-off must occur at about ⅓ of the stroke in the high-pressure cylinder. Will you kindly explain how so late a cut-off can be used in marine engines when it is not practical to do the same in land engines, unless these engines have a Corliss or Meyer valve gear? *A.*—It does not follow that, the area of the high-pressure piston being equal to ⅓ of the area of the intermediate piston, the cut off in the high-pressure cylinder must occur at ⅓ of the stroke; it was probably later than this. There are many stationary engines in which steam is cut off at ⅓ of the stroke, and even later than this. In ordinary slide valve engines there is no difficulty in designing a valve to cut off late, but there is difficulty to obtain a valve to cut off early without interfering with the other functions of the valve; this difficulty is overcome by using a Corliss or Meyer valve gear. 2. How much tension should be allowed on the driving side of a one-inch manila rope? *A.*—200 pounds. Your third question we do not understand.

(248) P. L., Minnville, Oregon, writes: In repairing broken parts of bicycle frames I cannot obtain good results in brazing. I use fine yellow spelter, or common sheet brass, and borax for flux; it does not flow good; the tubing seems to scale before the spelter flows. Please let me know how to overcome the difficulty. *A.*—Your trouble may be caused by not using the right kind of borax; there are three kinds of borax—the plain borax, borax which has been dried or calcined, and borax which has been melted and then broken to a coarse powder. The first kind when heated will swell, and does not flow readily over the surface. The second kind is nearly free from this defect. The third kind has nearly all the water driven out of it, and therefore forms a perfect covering for the metal. The common practice is to use some of the calcined borax and some of the melted borax, with which the joint is covered. The principal ingredients of the brazing solder should be copper and zinc; the proportion of the latter will govern the hardness; 2 of copper and 1 of zinc is often used for brazing; 1 of copper and 1 of zinc is more fusible. This solder can be bought of any composition. The work should be done quickly, because when the steel is exposed for a long time to a comparatively low heat its quality will be impaired. On the other hand, the joint must not be placed in an intensely hot flame, as this may also injure the steel. Skill and experience are required for satisfactory results.

(249) E. E. P., Jeffersonville, Ohio, asks: Can an average horse develop as much horse-power as a one-horse steam engine? *A.*—We should not expect a horse of the average weight and condition to do a day's work at the rate of a horse-power unit; it should do about two-thirds of this amount of work. A powerful horse may give a full horse-power. While at work the main elements of most effective operation are the load and the speed adopted at the time, and its distribution day by day and hour by hour. At maximum load the horse does the minimum work; at maximum speed it can carry no load; at some intermediate load and speed it gives the maximum work, and this maximum varies with the time of working day by day. It is higher for short, and lower for long working days. 2. How large a cannon will be required for doing the same work as was done with the most powerful war engine used by the ancients? *A.*—The battering ram was probably the most powerful war engine used by the ancients, but since there is nothing or very little known of the size of these rams, a satisfactory comparison between these and the cannon cannot be made. Probably the smallest cannon used in the army will, under favorable conditions, do as much or more effective work than the ram used by the ancients. 3. I have been informed that there are steam engines used in air ships, which weigh about five pounds only per horse-power, is this true? *A.*—The weight per horse-power of the smallest engine for an aerial vessel that we have heard of is eight pounds per horse-power. This engine is a compound engine and the ratio of weight given above includes a water-tube boiler with gasolene furnace. Your other question is out of our line.

(250) F. L. S., Brockton, Mass., writes: In your answer to Question 225 you give a rule for finding the head due to a given pressure, namely, multiply the pressure in pounds by 2.304; this rule is new to me, but I may be out of date. I take .43 pound per foot of head, and divide the pressure by .43, thus, the pressure per square inch being 100 pounds, I get $100 \div 43 = 232.55$ feet for the head. If this is not right I should be pleased to have you point out the error. *A.*—You are not out of date, you have adopted the right method for finding the head due to a given pressure, but .43 pound for a column of water 1 foot high and 1 inch square is too light, the weight of this column is generally taken at .434 pound. Now dividing 100 by .434 we have 230.4 feet for the head. The same result is obtained by multiplying the pressure of 100 pounds by 2.304 which you say is new to you. The correctness of the last rule can be easily shown, thus: Dividing 100 by .434 we can state in this way $\frac{100}{.434}$, and this is equal to $100 \times \frac{1}{.434}$; now reducing the fraction $\frac{1}{.434}$ to a decimal fraction we have $1 \div .434 = 2.304$, consequently,

$$\frac{100}{.434} = 100 \times \frac{1}{.434} = 100 \times 2.304.$$

We may look at this subject from another standpoint. In all these computations it is assumed that 62.5 pounds is the weight of one cubic foot of water; hence the weight of a column of water 1 inch square and 1 foot high is $62.5 \div 144 = .434$ pound, and therefore a column of water 1 inch square which will exert a pressure of 1 pound must be $\frac{1}{.434} = 2.304$ feet high. Hence to find the head due to a given pressure in pounds per square foot we multiply the pressure by 2.304, the result will be head in feet; and this is an easier and quicker way of finding the head than dividing the pressure by .434.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 472.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

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"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Where is the Twisting-off Machine?

One of the standard machines in the general machine shop is the shears for cutting off stock. A shop of reasonable size is at a considerable disadvantage without good shears; at the same time, it must be confessed that no standard operation of the shop is so unsatisfactory, so discreditable, so barbarous as that of cutting off metal with the shears. I do not here speak of the shearing of plates in the boiler shop or in the bridge or ship works, which is all right when the shears are all right and where they are then indispensable. But it is so often customary to use the shears for biting off bar iron or steel, round, square, flat, or of various special shapes, and the pieces cut off are always bent or mutilated or distorted out of shape by the pressure of the shears; and if the pieces cut off are for any purpose where it is essential to maintain the shape with any accuracy, quite an allowance must be made for dressing off the ends, and when this operation is completed the time and labor and material sacrificed will prove to be greater than if the cutting-off machine were used. A sheared end is an unpleasant thing to have to do with in a centering machine, and if the end of the piece is to be faced in the lathe, quite a large center is required to allow for the cutting back to the low side.

The cutting-off machine, of course, leaves its work in perfect condition. It wastes the thickness of the cut, but that is not of much importance. As a general thing, it is applicable to round stock only, and that limits the sphere of its usefulness. As I have operated nearly every machine known to the modern machine shop, it happened that once upon a time I found myself running a cutting-off machine. The usual practice in cutting off is to use a thin, square-nosed tool and to let it feed in until the piece drops off. If anyone has ever been compelled to stand and watch one of these machines in operation, he must have been more or less a victim of the illusion that it ran slower as the tool

neared the center, and if the looker-on happened to be somewhat interested in the amount of work turned out, he must have been more or less tormented by impatience. I was so tormented in this way that I could not endure it, and it became my custom in cutting off round stock, up to, say, one inch in diameter, to throw away the cutting-off tool and to use a V-tool to nick into the work about an eighth of an inch deep and then closing a strong pipe tongs suddenly upon the revolving projecting piece to twist it off. I used to cut off the work twice as fast as it could be cut off before, and the pieces cut off were in every way as satisfactory.

Since then I have been constantly looking for the twisting-off machine, and it has not yet appeared, and it may not have been even thought of. The cutting-off machine, as I remarked, seems to be almost exclusively adapted to round stock. The twisting-off machine, with a sufficient grip, would sever round stock with astonishing rapidity, but it would be more especially adapted to the other shapes, regular or special, of rods and bars. The other day I dropped into a scale works where they build a line of cheap scales. Each scale requires six or eight knife edges for the scale bearings formed of pieces of tool steel of the required shape cast into and projecting from the levers at the proper points. The steel is rolled to the shape and comes in rods 10 or 12 feet long, and it has been the practice to cut these up in pieces two or three inches long by shears. It need not be said that the condition of the pieces as they drop from the shears is not very satisfactory, and they require much labor to grind them into proper condition. The sectional shape of these pieces is circular for 240 degrees, and then the two tangents are produced until they meet and form an angle of 60 degrees, which is the knife edge of the scale bearing. Now, suppose we had two hardened steel disks, one fixed and the other movable, set face to face, and with a hole through the center of each just the shape of the rod to be cut off, and which the rod would just slip through. If the rod were then thrust through the hole until it struck a stop gauge set for the length of the piece to be cut off, and if, by any suitable mechanism, the movable disk were turned a sufficient distance, the piece would be cut off much more neatly than they have been doing it with the shears. That is the twisting-off machine. The shape of rod that I have been speaking of is not the most suitable for displaying the points of this system of cutting off material. If a square rod or bar were to be twisted off, the strain would come alike upon all the four corners, and at any point of the circle the opposite strains would always balance. There would be no possible bending of the piece in any direction and nothing to make the end of the piece anything other than perfectly square. Dies to open and close, and to clamp the piece tightly when the torsion occurred, and to release it immediately after, would be obviously better than the solid die. There would seem to be a fine opportunity here for a machine entirely automatic that would do its work better, quicker, cheaper than much of such work has heretofore been done.

Frank Richards.

If the person signing himself M. S. B., of Belfast, Ireland, had sent his full address, we would have been able to inform him by mail that it is our expectation soon to be able to publish some account of the new vessel to which he refers, and we would have preferred to inform him in that way, because thus we would have avoided occupying this space in the paper for that purpose. And this should be a suggestion to many others of our friends who have sent queries and communications signed only by initials or *nomes de plume*. It ought to be thoroughly understood that no newspaper can pay any attention to such communications.

We cannot give to our friend, signing himself "Loco. Eng.," the address he asks for, because "Loco. Eng.," does not give us his own address.

The Evolution of a Crank Disk and Shaft.

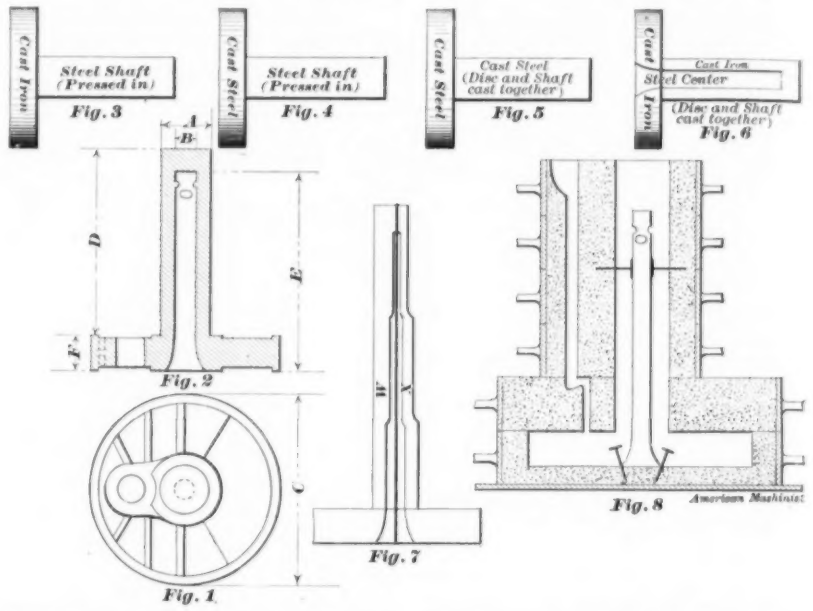
Around a great number of operations performed in the foundry, it has been customary for ages, to throw some sort of a mysterious veil, which made molders who were in the least inclined towards superstition, regard these as being only accomplished by persons having supernatural insight and intelligence, instead of being subject to physical laws and definitions.

The foundry, too, has in the past furnished more than its share of members of that unnamed tribe of humans who consider it dishonest to appropriate the benefit of others' experience, forgetting that they themselves have to a great extent escaped failures at the expense of others; yet there are foundries at the present time which would look upon the divulging of some of their operations as being outright robbery, and would deal summarily with the offender.

If such establishments have any claim to originality, let them apply for protection to our patent laws. The Builders Iron Foundry, of Providence, R. I., have set an example, or a precedent, in publishing through the mechanical press, descriptions of the building of the rifled mortars for the United States Government, that is worth following by others. Let things that are dark and tricks that are vain in the foundry, be held up for public scrutiny and research, and let those who are able to improve and do better, do so.

Every machinery molder knows what an engine crank is, and most of them are familiar with those which are in the form of a disk, used for a large number of engines. As ordinarily made, two spaces are cored out, and afterwards finished, one for the reception of the crank pin and the other for the shaft, both of which are pressed in under pressures which vary from what the management believes sufficient, to the limit of the strength of the metal.

A well-known automatic high-speed engine contains two of the disks shown in plan and section, Figs. 1 and 2. Being a high-speed engine the stroke is necessarily short, leaving but a small amount of metal between crank pin and shaft, often fractured in pressing in either, and although this would sometimes escape immediate detection, yet it was a source from which trouble could continually be expected. These disks were made as shown at Fig. 3, the disk being cast-iron with a steel shaft pressed in.



At Fig. 4 is shown an advancement, consisting of a cast-steel disk in place of cast-iron with a steel shaft pressed in. That this arrangement entails an extra expense is plain, but better results were, of course, procured, since steel has a greater tenacity.

Fig. 5 shows the next step taken to reduce the cost of production, where a cast-steel disk with a cast-steel shaft, both cast at one operation, displaces other forms. It is apparent, that a considerable saving is here effected, for the labor of fitting the disk and shaft and pressing them together is entirely dispensed with.

Fig. 6 shows to what stage of development this article has reached. Both disk and shaft being made of cast-iron, and cast together at one operation with a steel center placed in center of shaft and disk and cast in as shown.

In the fall of 1893 Messrs. Ide & Son cast three disks and shafts for experimenting, one of cast-iron solely, one of the same material, with a 1½-inch hole cored through the center of disk and shaft for its entire length, and one as shown at Fig. 6, with a 2½-inch steel center. Upon testing these the latter was found to possess the greatest strength. It would seem as if this conclusion could have been formed beforehand, for the diameter of the shafts being identical, the one cast solid was stronger than the one with a 1½-inch hole cored through it, because it contained a greater cross-sectional area; the one with a steel center cast through it was stronger than the one cast of nothing but iron, by at least the difference in strength between a shaft of steel 2½ inches in diameter, and a shaft of cast-iron of the same diameter.

What theory said was true, also proved in

Table Showing the Mixture of Iron Employed in the Production of the Ideal Crank Disks and Shafts.

Date of Heat.	Number of Shafts.	Size of Engine.	Charge of Iron for Disks and Shafts.				Transverse Strength of Test Bars in lbs. 1" Square Tested. 12" Between Supports.	Remarks.
			Car Wheel, lbs.	Salisbury, lbs.	Old Crank Disks, lbs.	Charge Following Special Mixture, lbs.		
Nov. 23, 1894.	3	14 x 14	1,500	900		Old Crank Disks, 600	3,300	
Dec. 8, 1894.	4	12 x 12	1,200	1,100		Hinckle, 800	1,900 and 2,100	Test bars defective.
Dec. 12, 1894.	2 1 1 1	12 x 12 10 x 10 8 x 10 8 x 10 Special.	900	1,300		Hinckle, 600	2,875	Length of special, 8 x 10 shaft, 33". Length of steel center, 26".
Dec. 26, 1894.	2	14 x 14 Special.	1,000	1,000		Hinckle, 400	2,650	Length of shafts, 36". Length of center, 31".
Dec. 29, 1894.	1 1 3	12 x 12 Special. 12 x 12 10 x 10	950	1,250		Hinckle, 600	None.	Length of special shaft, 54". Length of special center, 48".
Jan. 2, 1895.	5 2 2	6 x 6 8 x 10 10 x 10	900	1,400		Warner, 1,200	2,800	
Jan. 9, 1895.	1 2 1 2	10 x 10 8 x 10 10 x 10 Special. 8 x 10 Special.	900	1,400		Hinckle, 600	None.	Length of 10 x 10 shaft, 18". Length of 10 x 10 center, 40". Length of 8 x 10 shafts, 54". Length of 8 x 10 centers, 45.
Jan. 12, 1895.	2 3 1	8 x 10 Special. 10 x 10 6 x 6		700	1,500	Warner, 1,000	3,100	Dimensions of 8 x 10 special shafts same as given in heat of Jan. 9th.
Jan. 18, 1895.	2 2	12 x 12 12 x 12 Special.	1,300	1,600		Old Cylinder Iron (hard), 500	2,950	Length of special shafts, 66". Length of special centers, 54".
Feb. 6, 1895.	3	14 x 14	1,200	1,200		Warner, 900	3,125	
Feb. 13, 1895.	1 2	14 x 14 12 x 12	1,000	1,200		Warner, 800	3,700	
Feb. 16, 1895.	2 3 1	10 x 10 8 x 10 8 x 10 Special.	750	1,600		Warner, 800	3,000	Length of special shaft, 54". Length of special center, 48".
Feb. 23, 1895.	4	12 x 12	600	1,300	600	Old Cylinder (hard), 600	3,400	
Feb. 27, 1895.	2 2	10 x 10 12 x 12	800	1,000	600	Warner, 600	3,250	

this case true in practice, and although this could here be omitted, yet I feel somewhat like the fellow writing a biography, bound to keep close to the facts and occurrences.

The extraordinary use to which cast-iron is put in this case, is so much out of common practice that I could not very well avoid being interested in its development, especially so since it furnished the iron foundry, connected with the works, an extra amount of work, for which us molders were thankful during the dull period, then at its hight.

The iron is melted in a 34-inch Colliau cupola, in all cases at the first of the heat, as the iron is of a hard nature and melts more rapidly, that is, melts at a lower temperature than the softer brands of common iron, thus preventing to a great extent the softer brands in the following charges from being mixed with those intended for the disks. To secure as uniform results as possible, the iron for this purpose is at each heat tapped out in one ladle, and while there may be variations in the qualities of the metal, still all those shafts cast at any one heat, will be as near alike as it is possible to make them.

But three kinds of iron are used, or rather supposed to be used, for these disks, viz., Salisbury, old car wheels and old crank disks. What kind of iron follows this special charge is mentioned in each case, thus on January 9th, 600 pounds of Hinckle, and on January 12th, 1,000 pounds of Warner constituted the following charge. (This is mentioned here to show what kind of iron, if any, mixed with the special charge, for in running a heat, and a small one at that, it is a hard matter to keep the different charges from mixing).

It will be noticed that on several occasions the shafts are marked "special." This only implies that the length of shaft and center differs from the standard size, and the dimensions are quoted in each case. When cast these shafts appear as at *W*, Fig. 7, when finished somewhat like *X*, same figure.

The plan of molding these shafts may be seen at Fig. 8. This insures a solid shaft by casting it about 6 inches longer than wanted, and necessitates no feeding. This point will be appreciated by foundrymen who know how difficult it is to get a lot of castings fed solid, when help is wanted all over at once.

A peculiar phenomenon was observed in connection with the casting of these shafts. Upon one occasion when two of these were wanted of extraordinary length the superintendent, Mr. Richards, thought it advisable to heat the centers as hot as possible in the brass furnace just previous to casting. After being poured the metal refused to remain quiet in the top part of the shaft, and a large amount of gas was seen to escape through the molten metal. Feeding rods were employed and hot iron supplied to keep the heads open as long as possible, but after all the care taken the shafts were found to have several small cavities just above the steel center. As no trouble has been experienced on this account, when the centers have been used without heating, this can only be accounted for by supposing that the unification of the cast-iron and steel was attended with some chemical change, resulting in gas being produced, which escaped through the liquid iron as long as possible.

One thing noticed was that the union effected between the steel center and the cast-iron surrounding it was more perfect than those which were cast without heating the center. In this case the defective part was turned off and a new end burned on, just as is practiced with rolls. Some of these extra long shafts may be seen on engines at Daniel Scotten & Co., Detroit, Mich., also at the Chamber of Commerce, same place.

Are these shafts solid? many will undoubtedly ask, and anticipating such a question, I will say that of those defective shafts which have been broken up, the steel center has readily left its cast-iron covering, showing that no actual union existed between the two, that it is simply a case of one substance being covered with another. Many even hold the view that this cast-iron covering does not surround the steel center firmly, but that a space, though a very small one, exists between them. This theory is accounted for thus, when the cast-iron enters the mold and surrounds the steel center, a part of it on coming in contact with the cold steel becomes immediately chilled and remains so indefinitely. The steel center is by this time becoming heated and expands, forcing outwards this chilled portion, which is no longer in a molten state. When the steel center starts to cooling it shrinks away from this chilled portion, and if the cast-iron which remains between the center and the surface of the mold is unable to force together this chilled portion or possesses sufficient elasticity to avoid this, the center

THREE-SPINDLE DRILL PRESS.

will practically be loose; whether such is the case or not can be left for decision to anyone who takes an interest in these matters, with the knowledge that there is always somebody to be found on all sides of a question.

The strength of test pieces cannot be taken as an exact indication of the strength of the shaft. It is possible to make a test piece that shall be stronger than the shaft, but it will more generally be found that the shaft possesses a proportionally greater strength than that indicated by the test piece.

The reason for this discrepancy between the two is the fact that they are cast under different conditions. By the chilling effects exerted by the steel center the iron in the shaft becomes of a different character. It will thus be apparent that the statement regarding difference in strength between shaft and test piece is correct, for a weak iron would be made stronger by chilling, while an iron that possessed the limit of strength would be weakened in the same manner by an increase of combined carbon.

It may be said to be a very delicate matter to say what kind of cast-iron is most suitable for this purpose, since shafts of different diameters will each require a different kind of iron in order that their strength and wearing qualities may be nearly alike, for a mixture suitable for a shaft of small diameter would be too soft for a larger one, and a mixture satisfactory to the latter would be entirely too hard for the former.

In the table will be found a table of dimensions of different shafts and centers, a record of shafts cast for several months, with mixture of iron, strength of test pieces, and other matter of an interesting nature.

Springfield, Ill. H. HANSEN.

Now that steel is cheaper than wrought-iron, a process by which the former may be converted into the latter may yet prove of value. The use of some of the smokeless powders is found to effect this conversion upon the interior surface of the gun barrel.

Three-Spindle Drill Press.

We give an illustration of a drill press intended for manufacturing purposes espe cially. The three spindles (which are 10 inches apart) are driven by a continuous belt which also passes under the pulley at the bottom and rear of the column, and there is provision for adjusting the tension of this belt.

The spindles are counterbalanced by coiled springs, the tension of which can be adjusted to compensate for different chucks or tools used.

Each spindle has an independent stop motion, and the pulleys which drive them are of varying sizes to adapt them for the use of different sizes of drills or of counterbores simultaneously.

The machine is so arranged that two men can work at it together if desired; a clutch mechanism permitting any one spindle to be stopped or started independently of the others.

The machine is built by The George Burnham Co, 15 Hermon street, Worcester, Mass.

The Corliss Engine Gets There—But How?

The following communication to the London *Engineer* has interested us, and we doubt not that it will be of interest to our readers. The writer suggests a topic which it would still be possible and profitable to remark upon. We are of the opinion that he does not suggest all the lines that are open for inquiry and comparison between the different types of valves and valve motions and business methods. We abstract from the letter as follows:

In the first place, as regards fashion, the engineers of the United States have never taken kindly to the link motion or to Mayer's gear. From a very early period they followed Corliss and Wheelock, and worked on their lines, while English engineers stuck to the slide valve and various modifications of it. Trip-gear engines constitute 90 per cent. of all the stationary engines built in the United States. Now the Yankee salesman knows what he is about, and he has fairly beaten the English traveler or agent in the gold fields of Africa for one place; in India for another; in Australia for a third, and the result is that if the English makers want to sell an engine it must be modeled on American patterns. It must be to all intents and purposes an American engine. There are trip gear engines of various types. The Corliss engine has rotatory cylindrical valves; but the Sulzer, and many other Continental engines, have double-beat drop valves. Engines of this type are, in my opinion and that of many others, better than the Corliss type; but they are, I understand, unsalable in Africa and India, Australia, Japan, and South America, simply because the Yankee traveler has been too much for the French, Belgian, Swiss and German travelers. So far, then, I think it is clear that the fashionable demand for Corliss engines has nothing to do with the merits or demerits of the type. Americans have persuaded our markets that the engine with cylindrical distribution valves, semi-rotatory, and fitted with trip gear, are the best; Senor Gonzales Pintos buys a Corliss engine, and Senor M. de Alvarez must have another of the same kind. The United Express Gold Company purchases a Corliss engine; the proprietors of the Wilderness Golden Calf Mines will not be satisfied with anything else, and so the game goes on and the ball rolls.

Next let us consider what is gained by the use of the trip gear, either Corliss, or Wheelock, or Sulzer, or Bollinckx, or Robey, or any other. It is claimed for the trip-gear engine that the clearance is the smallest possible. That is one claim. The other is that a better diagram is obtained than with any slide-valve engine. What is really gained may, I think, be shown by superimposing a Corliss diagram upon that of a slide-valve cut-off, and shading in black the difference at the point of cut-off.

To get this, however, about fifteen separate joints and pins and two air dash pots are needed. The number of joints and pins and separate parts varies, but I cannot call to mind any Corliss gear engine with less than fifteen for each cylinder, and there was an engine in the last Paris Exhibition in which I counted twenty-seven joints for one cylinder. Now, I shall be very much obliged to any reader who will tell me, a practical man, what is the special virtue of the black space in the diagram, and how many pounds of feed-water per indicated horse-power per hour it saves, or is reported to save. So far as I can see, any engine with the Mayer type of cut-off can give a diagram as good in all respects as the Corliss diagram, with the exception of the black bit. But it will be said the economy of the Corliss gear is due to the reduction of clearance far below what is possible with a slide-valve engine. This latter statement is not true. More years ago than I care to count, Seward patented and made marine engines in which the clearance, so far as the valves were concerned, was as small as can be got with any Corliss engine. If I am not mistaken, Messrs. Galloways had an engine driving an electric light installation in South Kensington, at, I think, the Indian and Colonial Exhibition, in which the clearance was extremely small, although the engine had slide valves. The portable engine with which the Reading Ironworks Company divided the prize with Messrs. Clayton and Shuttleworth, in 1871, had minimum clearance. The clearance in the Porter-Allen slide-valve engine is about 3 per cent. only.

To sum up then, it seems to me that the present demand for Corliss engines is principally due to the action of American travelers, who are better business men than our travelers. In the next place, it is due to the neglect of English engineers to make the most of the slide-valve type. Lastly, it remains to be proved that any trip gear can do more than shape a corner in a diagram as I have marked it in black. It may be said that the trip-gear engine is more economical than any slide-valve engine, however perfect. One object I have had in writing this letter is to ask some one or other of your numerous readers to tell me the reason why.

FRICTION-DRIVEN DRILL PRESS.

Improved Friction-Driven Drill.

We have illustrated in a previous issue the prototype of this friction-driven drill-press, and now show it in its latest and improved form, having a round column to which the table arm is clamped, and inside this column a counterbalance weight.

It will be remembered that this friction drive is so arranged that the moment of its

force is greatest at slow speeds when the larger drills are being used, and that the upward thrust on the drill spindle gives the contact of friction disk and wheel, which contact is automatically released when the drilling stops.

The machine is made by the Stover Novelty Works, Freeport, Ill.

NEW CATALOGS.

Those who are interested in the lubrication of machinery, as we suppose nearly all of our readers are, will find matter of value in a pamphlet entitled "Lubrication," which is issued by the Vacuum Oil Co., of Rochester, N. Y.

We have received from the Sulzer-Vogt Machine Co., Louisville, Ky., a supplement to their elevator catalog which explains the advantages of their electric elevators. Illustrations and descriptions are given of various forms and details. The catalog is standard size, 6"x9".

We have received from the University of Illinois (Champaign, Ill.), its catalog for 1894-95, which shows that this well-known school is in good condition, and perhaps better prepared to teach in various branches than ever before. Professor Breckenridge, who is known to our readers, is at the head of the mechanical engineering department. The catalog is $5\frac{5}{16}$"x$7\frac{5}{8}$".

We have received from the Keuffel & Esser Co., 127 Fulton street, New York, a catalog illustrating and describing the Pilot file system, which is designed for office use in filing letters and business papers of various kinds. The system seems to have advantages peculiar to itself, and is undoubtedly well worthy of investigation by those who are interested in filing systems. If this catalog were ¼ inch higher it would be standard size, 6"x9".

MANUFACTURES

The Union Drawn Steel Co., of Beaver Falls, Pa., proposes to enlarge its works shortly.

The Hyde Windlass Co. has been organized at Bath, Me., with a capital of $100,000.

The East Lake Woolen Mill Co. has concluded to erect its proposed $75,000 plant at Rossville, Ga.

The Erwin Cotton Mills, of Durham, N. C., will erect another addition to its plant this summer.

R. T. Fewell, of Rock Hill, S. C., has organized a company to build a cotton-mill. Its capital is $100,000.

The Standard Tin-plate Manufacturing Co., of Chicago, Ill., has been organized with a capital of $200,000.

The Parker-Russell Mining and Machine Co., of St. Louis, Mo., will shortly erect a plant. It is to be 200 by 240 feet.

The Kansas City (Mo.) Anti-friction Metal Co. has been incorporated by Wm. and Fred Huttig; its capital is $10,000.

Business is improving with the Singer Mfg. Co., so that the shops at Elizabeth, N. J., are employing more men.

The Pugh Electric Light and Power Company, of Cincinnati, Ohio, has been incorporated with a capital stock of $5,000.

The Cambridge Punch, Shear and Roll Co., of Cambridge City, Ind., has been incorporated with a capital of $50,000.

The Park Manufacturing Co., of Charlotte, N. C., will shortly erect its pump and heater works. J. R. Phan is interested.

The St. Joseph (Mo.) Pump Co.'s machine and blacksmith shops, which were lately destroyed by fire, are shortly to be rebuilt.

The Cedartown (Ga.) Cotton Manufacturing Co., has been incorporated with a capital of $18,000. Chas. Roberts is interested.

The Euclid Manufacturing Co., of Chicago, Ill., has been incorporated by Kickham Scanlan and E. G. Grover, with a capital of $100,000.

The Berlin Iron Bridge Co., of East Berlin, Conn., have just completed a new boiler house roof for the Stanley Works, at New Britain, Conn.

The Akron Hydraulic Press Brick Co., of St. Louis, Mo., has been organized by O. C. Barber and S. S. Kimbell, with a capital stock of $300,000.

The Smith Scale Co. has removed its works to Tupelo, Miss., and organized the Smith Scale and Foundry Co., with a capital of $10,000 to operate a plant.

The Burlington (Iowa) Boiler, Engine and Machine Works has been incorporated with a capital of $100,000. The incorporators are Geo. H. Higbee and F. A. Millard.

The Swainsboro (Ga.) Manufacturing Co. has been organized with a capital of $250,000. Jesse Thompson is interested. The company shortly intends to erect a plant.

The J. A. Fay & Egan Co., of Cincinnati, Ohio, have been awarded the first prize on their exhibit of woodworking machinery at the International Fair, held at Santiago, Chili.

Messrs. Taft & McNear, of Toledo, Ohio, are building at Angelica, N. Y., a creamery of the most modern construction. The equipment of machinery will be of the latest and most approved designs, and no expense will be spared in making it a model establishment.

Mr. David McDowell, who has for some time past been connected with Chas. H. Besly & Co., Chicago, Ill., has connected himself with a new enterprise, and has organized the firm of McDowell, Stocker & Co., which will deal in new and second-hand machinery at 61 S. Canal street, Chicago, Ill.

The Standard Machine Co. has been organized at Lebanon, Pa., for the manufacture of various kinds of automatic machinery, and especially grinding and polishing machinery. The company expects to make match machinery, wire-forming machines and various other kinds of special machinery for special purposes. Mr. R. C. Greer, who was formerly with the Pond Machine Tool Co., is manager and mechanical engineer.

The twist drill business formerly carried on under the name of J. D. Foot, but really belonging to the Kearney & Foot Co., Newark, N. J., the well-known file manufacturers, will be continued by that company, who will place on the market a twist drill of their own manufacture, which will be sold under the trade-mark "K. & F.," the same as the files referred to. We are informed that it is the intention to make these drills of very high quality.

At a recent annual meeting of the Wm. Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa., three of the brothers Cramp, William M., Jacob C., and Samuel H., retired from the directory, in accordance with a plan which had been arranged for some years ago, the retiring gentlemen not having taken an active part in the management of the affairs of the company for some time past. The management of affairs remains in the hands of Charles H. Cramp, and Henry W. and Edwin S., his sons, the last named being the superintending engineer.

The Joseph Dixon Crucible Co. are experiencing a difficulty frequently met with in manufacturing, resulting from substitution of other things for their graphite paint, the assumption being in some cases that any mixture of black lead and oil ground together is essentially the same thing. Some time ago one of the departments of the U. S. Navy ordered 100 pounds of Dixon's graphite paint of a well-known dealer. The dealer not having that quantity on hand in an original package filled a keg from a barrel of Dixon's paint and sent it forward. It was promptly returned by the Government officials with the remark, that they had experimented enough with other makes and would only receive original packages. The flake graphite mined at Ticonderoga when used in such paint for the protection of metallic surfaces, seems to cause the flakes to overlap each other, after the manner of fine fish scales, forming a covering of great elasticity and durability.

Machinists' Supplies and Iron.

New York, June 8, 1895.

Iron—American Pig—We quote standard brands, $12.25 to $12.50 for No. 1; $11.25 to $11.50 for No. 2, and $10.75 to $11.00 for No 2 Plain. Southern brands, $12 to $12.25 for No. 1; $11.25 to $11.50 for No. 2; $10.75 to $11 for No. 3; $11.25 to $11.50 for No. 1 soft; $11 to $11.25 for No. 2 soft; and Foundry No. 4, $10.50 to $10.75.

Antimony—The market is dull, but no change in prices. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8½c. to 8¾c.; Hallett's, 7.05c. to 7½c.; U. S. French Star, 7¼c., and Japanese, 7c. to 7¼c.

Lard Oil—Prime City we quote at 52c. to 53c.

Copper—The market is firm. Lake Copper has changed hands at 10¾c., but 10⅝c. may buy. The demand for Casting Copper at 10.10c. to 10.20c. is improving.

Lead—The market is fairly active, and prices have advanced to 3.32½c. for New York delivery.

Spelter—The consumers' demand continues good at 3.75c. for New York delivery.

Tin—The market is weak. For spot and current month delivery 14.22½c. to 14.25c. is quoted, and futures have been offered at 14.20c.

WANTED

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Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

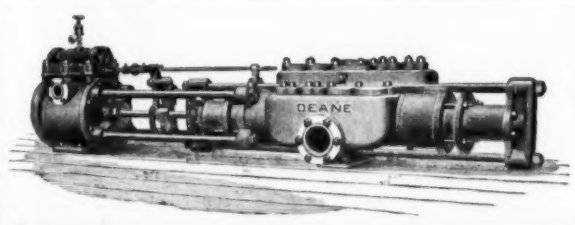
Mech. draftsman with good education and 10 years' experience wants position. Box 15, Am. Mach.

First-class machinist wants position; competent to take charge of shop. B. C., Am. Machinist.

Wanted—By a draftsman in mill engineer's office, a place with some mfg. concern; familiar with machine details and design. Box 16, Am. Mach.

Situation wanted by a practical mach., energetic, exp'd in handling men, up in modern shop practice, reference furnished. Box 19, Am. Machinist.

(*Continued on Page* 473.)



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Mech. eng. and supt. wants pos., 25 yrs. on high-class work, handling men, modern methods; first-class references. M. E. S., AMERICAN MACHINIST.

Wanted—Position as woodwork instructor in trade, technical or M. T. school exp. teacher; also as pattern foreman in electric steam and mechanical work 12 yrs., best refs. BOX 10, AM. MACH.

Twist Drills—A practical man who is thoroughly experienced in the manufacture of twist drills can secure a good position; give full particulars, age, etc. Drills, care of AMERICAN MACHINIST.

Competent draftsman with tech. training and long experience in estimating, designing and mfg. hydraulic and special machinery, desires engagement. "Attention to Details," BOX 20, AM. MACH.

Wanted—Position by live, energetic mechanic of 20 yrs. exp., thoroughly up in modern methods of doing work; excellent draftsman and designer. Held positions as foreman, asst. supt. and chief draftsman, with large mfg. firms. O. P., AM. MACH.

A man with long exp. in light manufacturing, at present mech. superintendent, would like similar position. First-class references from present firm. Address in first instance, Confidential, BOX 17, AMERICAN MACHINIST.

Wanted foremanship by one who is well up in locomotive foundry practice; have had eight years' experience as foreman; understands thoroughly iron, brass, dry sand and green sand work, can give best of refs. BOX 14, AMERICAN MACHINIST.

Wanted—Superintendent and mechanical engineer; one thoroughly capable in designing Corliss engines of all kinds and the handling of 300 men; an experienced man only. Address, with references, A. B. C., care of AMERICAN MACHINIST.

Wanted—One first-class molder who understands green and dry sand molding and making of steam engine castings thoroughly; to a good mechanic we will give a steady job and good pay. Address "Foundry," care of AM. MACHINIST, New York.

Wanted—A position as assistant to supt. or foreman by good machinist, at present in charge; can make a good shop drawing, etc.; would accept a position as machinist in some good shop; sober and industrious, west of Ohio preferred. Box 18, AMERICAN MACHINIST.

Wanted—An energetic foreman of a bridge mfg. company's machine shop. Should be familiar with bridge work, machinery of plant, and capable of general repairs. State age, experience and salary expected. Plant is a large one, and good salary paid to competent man. X. Y., AM. MACHINIST.

Wanted in a western city in a well-organized modern machine tool shop, building high-grade work only, a leading vise hand, fully capable to direct a half dozen other vise hands, and to work along with them. Must be a hustler, and able to produce the best work at a competitive cost. Address, stating age, married or single, wages wanted, and references, X. Y. Z., AMERICAN MACHINIST.

A general manager wanted for a steam engine and dynamo-electric manufacturing establishment; must have experience, energy and executive ability, and be able to put some capital into the business; a modern plant, located near New York, costing over $200,000; a "going concern," with abundance of profitable orders already secured, offers unusual inducements for capital and experience. Address, giving experience and references, F. J. K., Post Office Drawer 171, Buffalo, N. Y.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

(*Continued on Page 474.*)

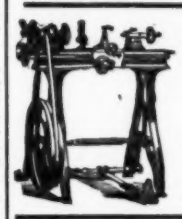
REDUCED PRICES OF

LeCOUNT'S LIGHT STEEL DOG.

No.	INCH.	PRICE.	No.	INCH.	PRICE
1	5/8	$ .35	8	2	$1.10
2	11/16	.35	Small set of 8—5.50		
3	3/4	.50	9	2 3/8	1.40
4	1	.60	10	3	1.50
5	1 1/4	.75	11	3 1/2	1.70
6	1 1/2	.85	12	4	1.90
7	1 3/4	1.00	Full set of 12—12.00		

C. W. LeCOUNT, South Norwalk, Conn.

These goods are for sale by CHAS. CHURCHILL & CO., L'v'd, 21 Cross St., London, England.



Star Foot-power Screw Cutting Lathes Automatic Cross Feed

9 and 12 inch Swing.

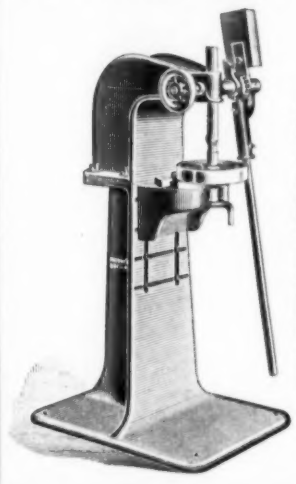
New Designs. Novel Features.

Send for Catalogue B.

SENECA FALLS MFG. COMPANY

687 Water St., Seneca Falls, N. Y.

The Greenerd Arbor Press.



PATENTED DECEMBER 1, 1891.

For Sale at Manufacturers' Prices by

A. J. WILKINSON & CO.,

180 to 188 Washington St., BOSTON, MASS.

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MACHINISTS: Look at This Vise,

for holding small stock while drilling. Can be adjusted to work of any shape, or of different sizes, in 30 seconds. You save time, drills, material, by using. Write us.

THE DRILLING VISE CO., Chicago.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

NICHOLSON FILE CO.

PROVIDENCE, R. I., U. S. A.

3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

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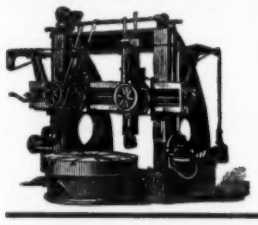
Manufacturers of Set, Cap & Machine Screws, Studs, etc.



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COMBINING EVERY IMPROVEMENT.

14 SIZES FROM 5 TO 20 FEET.

BETTS MACHINE COMPANY,

WILMINGTON, DEL.

WANTED—MACHINERY as follows:

Must be in First-class Order and Cheap.

One 24-inch Engine Lathe.
One 24-inch Metal Planer.
One 18-inch Shaper.
One 20-inch Drill Press.
250 to 800 Pound Drop Hammers.
3,000 to 5,000 Pound Punch Presses.
Two Boilers, 50 to 60 Horse Power, each.

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Any Style or Graduation.

(5 Sizes, Metric and Vernier System.)

NONE BETTER.

Send for Catalogue and Special Prices to

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ABSOLUTELY K & M FIRE-PROOF.

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SECTIONAL STEAM PIPE AND BOILER COVERINGS.

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New York, Robert A. Keasbey, 54 Warren Street.
Philadelphia, Macan & Co., 1420 Callowhill Street.
Baltimore, Wallace & Bro., 432 East Pratt Street.
Washington, Wm. B. Morgan, Room 19, Builders' Exchange.
Chicago, Walch & Wyeth, 208 Lake Street.
New Orleans, Delbert Engineering Co., 23 Union Street.
Memphis, Symmes & Co., 162 Front Street.
Milwaukee, Wis., F. Sprinkman, 133 Sycamore Street.
St. Louis, F. Bocler, 108 Walnut Street.

THE GREAT COAL SAVER.

Manufactured by THE KEASBEY & MATTISON CO.

CINCINNATI: 114 W. Second Street. AMBLER, Pennsylvania. CLEVELAND: 117 Water Street.

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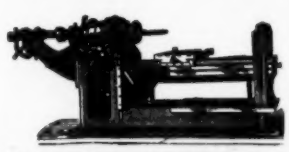
Detroit, S. P. Conkling, 20 Atwater Street, East.
Minneapolis, Arthur L. Otto, 219 South 3d Street.
Des Moines, J. C. & R. B. Carter.
Omaha, Spencer Otis, 307 S. Sixteenth Street.
Kansas City, J. H. Storer & Co.
Denver, C. W. Badgley & Co., 18th and Market Streets.
Salt Lake City, Utah and Montana Machinery Co.
Butte City, Montana, R. W. James.
Montreal, Sclater Asbestos Mfg. Co.
San Francisco, De Solla & Deussing, 2 California Street

FITCHBURG TOOLS.

DRILLS

FITCHBURG MACHINE WORKS.

FITCHBURG, MASS.



Horizontal Boring and Drilling Machine.

Ask for Catalog E.

BUILDERS IRON FOUNDRY,

FOUNDERS AND MACHINISTS,

PROVIDENCE, R. I.

We can guarantee that our castings will be uniform and of high tensile strength. Tensile strength of ten specimens taken from an air furnace heat:

34,260 lbs.	34,390 lbs.	32,600 lbs.	33,200 lbs.	34,400 lbs.
36,420 "	34,650 "	32,460 "	36,550 "	36,700 "

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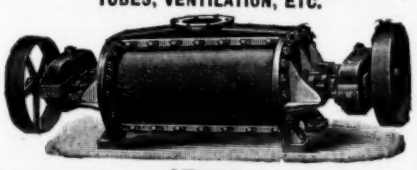
For FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.



SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.

BEST MECHANICAL CONSTRUCTION.

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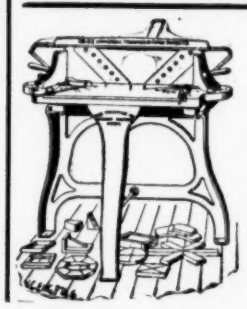

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Universal Trimmer

is the only one that has an accurate adjustment of the gauges. Cannot be set wrong. Work must be correct. Time saved in Pattern-making and all wood-working.

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JESSOP'S STEEL

FOR TOOLS, DRILLS, DIES, &c.

ALL KINDS IN STOCK.

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Chief Am. Office, 91 JOHN ST., N. Y.

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Established a century ago.

Medal World's Columbian Exposition 1893.

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Gentlemen:

In reply to your inquiry about what I think of the STYRIAN STEEL, I would say that I made Sub-Press Punches and Dies of it and did work where I could not get any other Steel to stand, and I think it is the best Steel in the world, and I have tried about all of them.

Yours truly,
(Signed) GEO. M. GRISWOLD.

This Steel was Extra Tough and Hard.

HOUGHTON & RICHARDS,

SOLE AMERICAN AGENTS,

148 & 150 OLIVER ST., BOSTON

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✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

Bicycle Repair Outfit. Send 6 cents postage for full illus. catalog. Frasse, 17 Warren St., New York.

For Sale—An 8x8x7 duplex Clayton air compressor nearly new. Compressor, Am. Machinist.

Wanted—Partner with $20,000 to mfr. gas engines pat'd. J. Werschmidt, 34 Kenwood St., Cleveland, O.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

Very valuable patent for sale, of March 26, 1895, No. 536,306, covering single sheared and gang ploughs; price reasonable. Address M. Weber, Room 27, Wood Building, New York.

A permanent situa'n in Lancashire (Eng.) is open for a manager in a small toolmaking establishm't employing 150 men; experience in the systematic management of work and men required. Reference given to applicant conversant with mass product'n upon the American system. Write, stating salary required, to T. T., Box P., 52,352 Smith's Advertising Agency, 132 Fleet street, London, E. C. England.

CLEVELAND TWIST DRILL CO'.S GRIP SOCKETS.

No More Twisted Tangs.

Larger drills can be used with smaller shanks than ever before.

No charge for the groove in the shanks.

Send for Descriptive Price List.

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ENGINE LATHES.

13 in. x 6 ft. Blaisdell.
14 " x 6 " Hendey Taper Att.
14 " x 6 " Flather.
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18 " x 8 " Fitchburg.
20 " x 8 " Pond.
20 " x 10 " Putnam.
20 " x 8 " Prentiss.
24 " x 12 " New Haven.
24 " x 10 " Standard.
24 " x 22 " Perkins
28 " x 16 " Fay & Scott.
30 " x 26 " Shafting atts.
32 " x 16 " Waterman.
35 " x 15 " Hewes & Phillips.
72 " x 20 " Union.

DRILLS.

Sensitive Drills Improved.
24 in Bk. Gd Auto. Fd., Prentiss.
28 in. Back Geared, Blaisdell.
Radials, 3, 4 and 5 ft. Arms.

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Sellers, 54 in. swing, complete.
Bement, 54 in. swing, No. 2.
Cyl. Borer 12 to 36 in. cyls.

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22 in. x 4 ft., Pond.
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24 " x 6 " Rochester.
30 " x 7 " Pond.
30 " x 10 " Harrington.
42 " x 12 " Gleason.

SHAPERS.

8 in. Stroke, Crank Motion.
15 " " " "Gould & E.
16 " " " "Prentiss.
16 " " " "Standard.
14 " " Trav. Head, with centers, circular feed, Fitch'g.

SLOTTERS.

10 in. Stroke, Lowell.
18 " " Bement.

BOILER ROLLS.

7¼ and 8 ft. Improved style.

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P. & W. No. 2 Wire Feed.
Brown & Sharpe No. 5, complete.

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P. & W. No. 2 Hand.
Garvin No. 3 Power Feed.
Lincoln Pattern with Vise.

Gray Planers "NEW," 22, 24, 30 and 36 in.
Kempsmith Millers, Universal and Plain
Bardons & Oliver's Screw Machines, Improved Style.
Fitchburg Lathes, 14 to 72 in. Swing.

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BEFORE REMOVAL.

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6 ft. Engine Lathe.
22 " 12 " " "
29 " 13½ " " "
26 " 20 " " "
29 " 12 " " "
37 " 30 " " "
71 " 18 " " "
52 " 20 " " "

19-36 and 50 in Drills.
Portable Drill.
24 in. x 5 ft. Planer.
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12 in. Shaper Traverse Head.
Gear Cutter, 54 in.
Milling Machine.

10 ft.-16 ft. Vertical Boring and Turning Mill, Cranes, Blower, Boiler Rolls, Punch and Shear, etc.

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BALLOU TOOL-ROOM LATHE, WITH CHUCKS.
BROWN & SHARPE UNIVERSAL MILLER, No. 1.
AMES TWO-SPINDLE PROFILER.
FERRACUTE DRAWING PRESS.
UNIVERSAL CUTTER AND REAMER GRINDER.
FOUR-SPINDLE POWER FEED DRILL.

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14 in. x 4 ft. Blaisdell, Taper.
16 in x 6 ft Perkins, Taper.
16 in. x 8 ft. Perkins, Taper.
16 in x 8 ft Blaisdell.
18 in. x 10 ft. Blaisdell.
28 in. x 20 ft. Perkins.
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PLANERS.

16 in. x 16 in. x 4 ft. Hendey.
23 in. x 23 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.

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12 in. Juengst. Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
18 in. Putnam, Traverse Head.
18 in. Smith & Silk. Crank.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
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4 10 in. x 41 in. Garvin.
1 12 in. x 4 ft. Stewart Pattern.

HAND LATHES.

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1 12 in. x 5 ft. Back Geared.
1 20 in. x 8 ft. " "

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Garvin Profiler, one spindle.
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No. 1 Brown & Sharpe Screw Machine.
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21 in. Squaring Shear.
14 ft. Power Draw Bench.
250 lb. Gould & E. Drop Press.
100 lb. Stiles Power Drop Press.
3 75 lb. Drop Presses.
No. 31 Eaton Double-acting Press.
No. 2 Garvin Wire Spring Coiler.
Several Woodworking Machines.

Also, a large number of other machines. Write for complete list, detailed descriptions and prices.

THE GARVIN MACHINE CO.,

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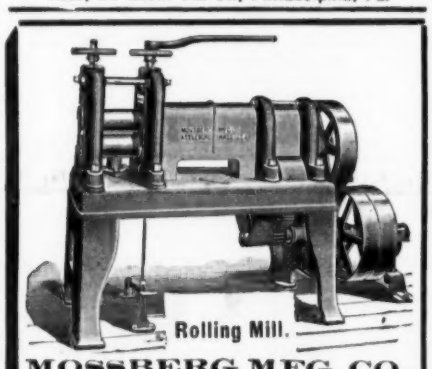
Also, 51 North 7th St., Philadelphia, Pa.



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Jewelers' and Silversmiths' Tools.

NEW IDEAS! NEW DESIGNS!

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Roots' Pressure Blowers Nos. 1, 2 and 6, " "
Open-die Bolt Cutter, cuts up to ¾ in., " "
" " " " " 1¼ " " "
Lot 6¼ and 7½ in. Shafting, Pulleys and Bearings, nearly new, at less than half value.

COOKE & CO.,

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The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

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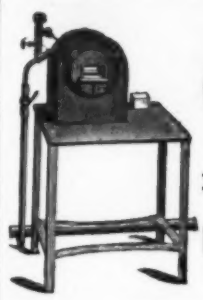
Torrington, Conn.



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OIL GAS PLANTS

GAS BLAST FURNACES and HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

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As Good As New.

One Large Planer.

Made by the Pond Machine Tool Co. Planes 54 in. square and 25 ft. long, with two heads on the cross rail. Will be sold at

A BARGAIN.

Must be sold and removed within **thirty days.**

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Machinery Merchants,

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WANTED

TO BUY FOR CASH.

First-class Second-hand Engine Lathes, Planers, Drill Presses, Shapers, Milling Machines, etc., address,

The Fosdick & Plucker Machine Tool Co.,

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IF YOU WANT ANYTHING IN THE LINE OF

DROP PRESSES · DROP HAMMERS · STAMPS OR AUTOMATIC DROP LIFTERS ·

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MACHINE TOOLS.

IN FIRST-CLASS CONDITION.

72 in. Niles Tool Works Vertical Boring and Turning Machine, 2 Heads.
16 in. F. B. Miles Slotting Machine.
2,400 Pound Miles Steam Hammer, Single Standard.
30 in. by 27 ft. Pratt & Whitney Engine Lathe.
Horizontal or Floor Boring Machine, Pratt & Whitney.
Two (2) 5 ft. Universal Radial Drills.
21 in. x 11 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
19 in. x 8 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
26 in. x 8 ft. Pond Machine Tool Co. Engine Lathe.
19 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
22 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
21 in. x 11 ft. Lodge & Davis Engine Lathe, Hollow Spindle and Taper Attachment.
40 in. Bement Vertical Drilling Machine.
24 in. Pratt & Whitney Vertical Drilling Machine.

GEORGE PLACE MACHINE CO.,

145 Broadway & 86 Liberty St., New York.

EMERY WHEELS.

The R. J. Costain New Process Emery and Corundum Wheels are the wheels you want. We require only two days in which to make and ship any grade of the regular sizes and style of wheel. Give us a trial. Satisfaction guaranteed or no sale.

The Electric Emery Wheel Co., Hartford, Conn.

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STUDY MECHANICAL OR ELECTRICAL ENGINEERING AT HOME

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AND LABOR-SAVING MACHINES OF EVERY DESCRIPTION.

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TRADE MARK NEW PROCESS STEEL BALLS

For all Anti-Friction Purposes.

WE ALSO MANUFACTURE

AUTOMATIC SCREW MACHINES

AND

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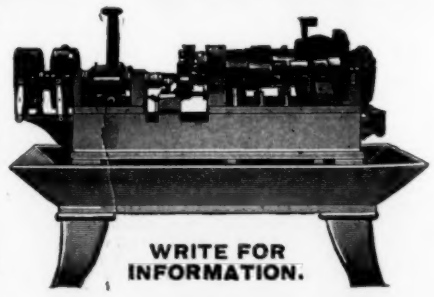

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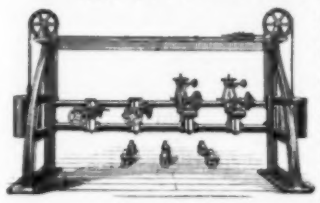

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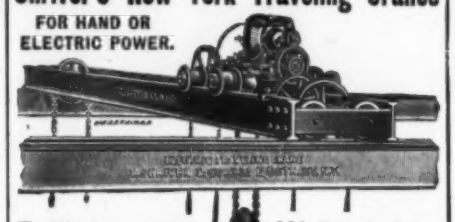

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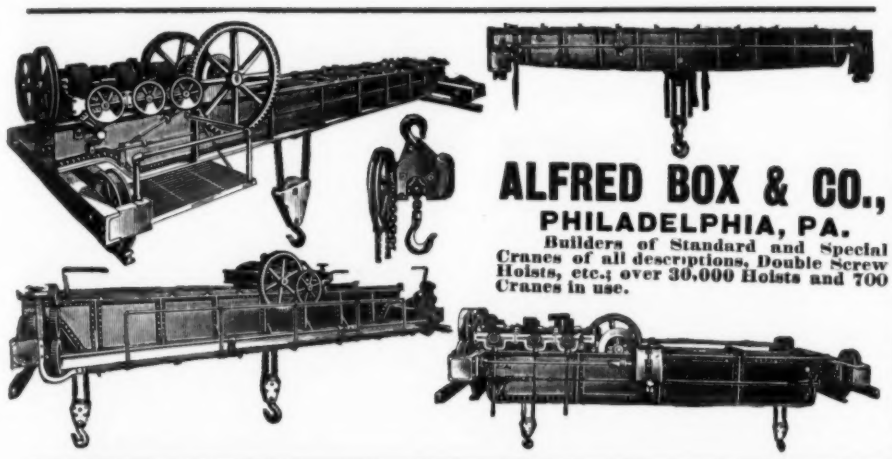

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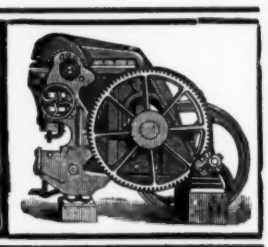

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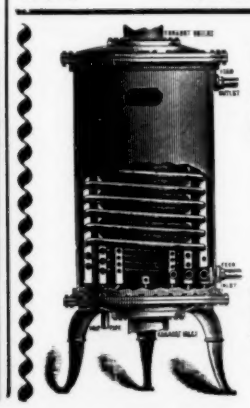

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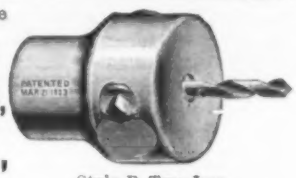

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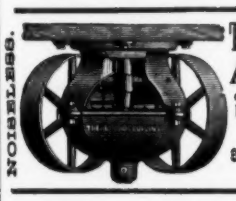

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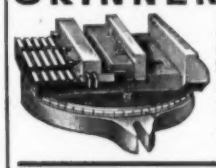

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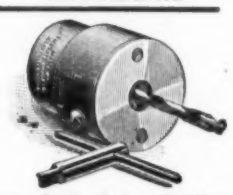

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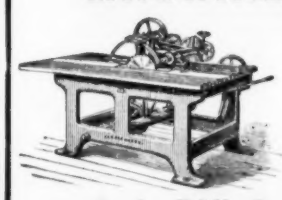

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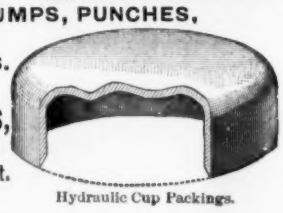

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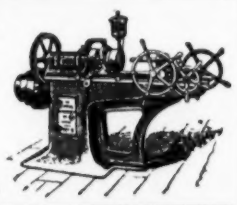

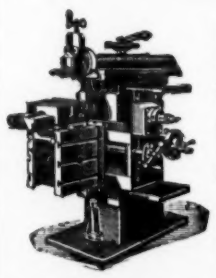

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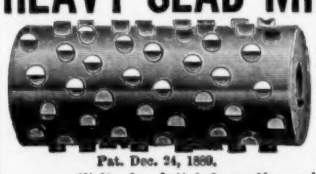

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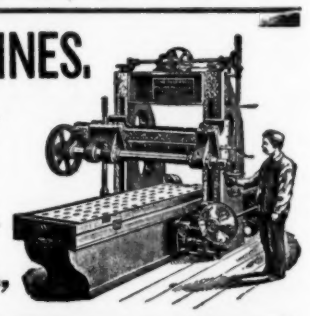

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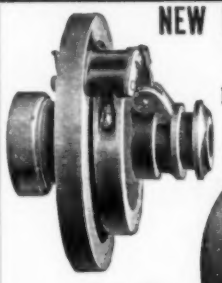

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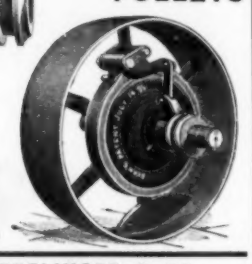

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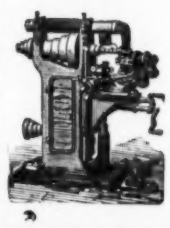

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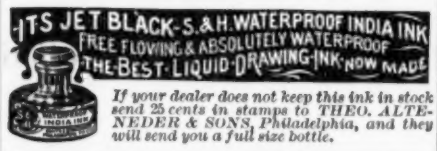

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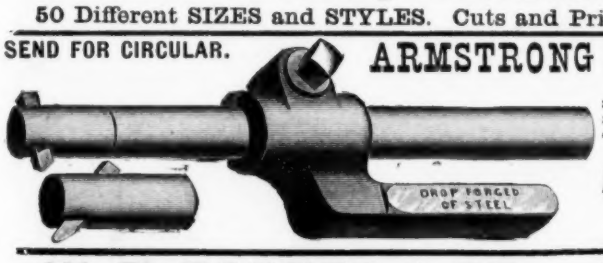

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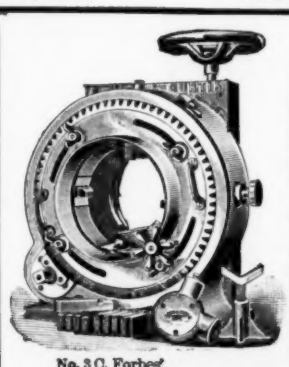

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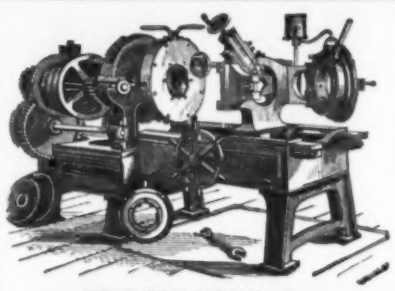

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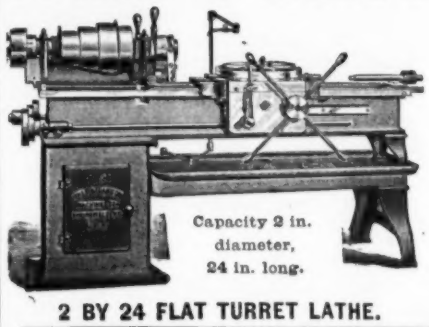

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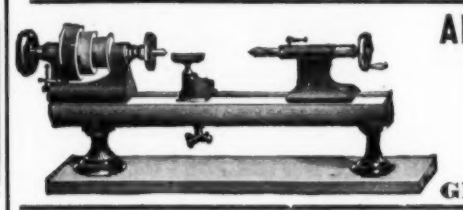

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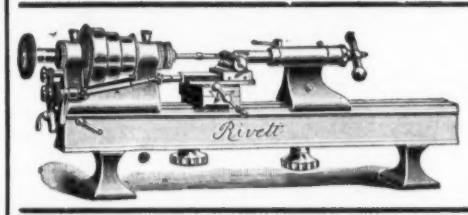

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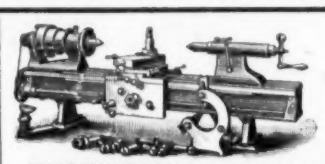

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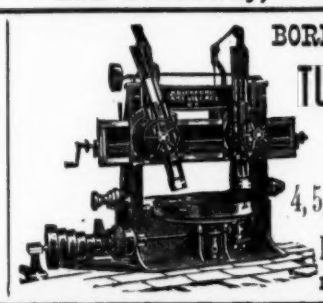

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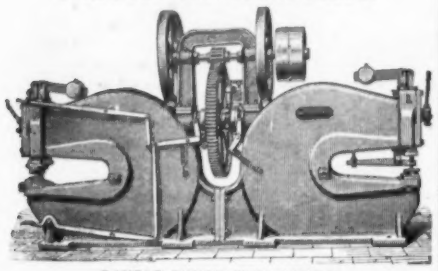

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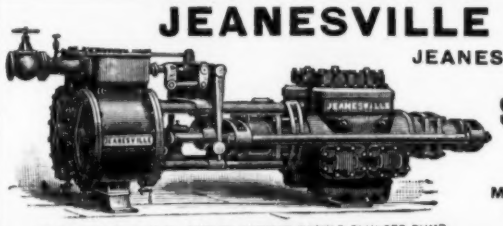

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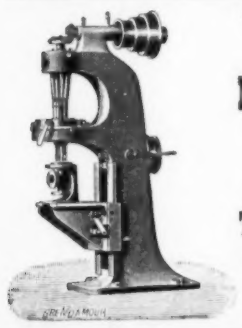

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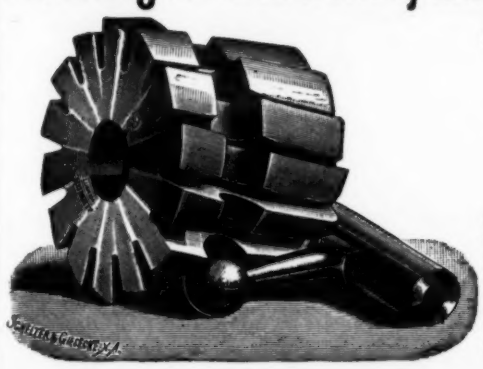

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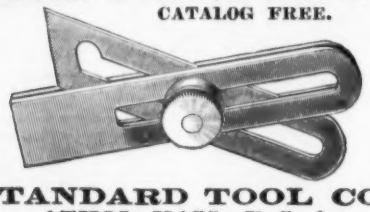

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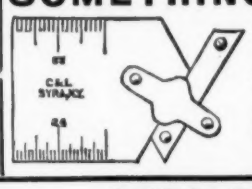

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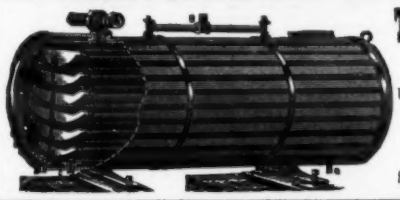

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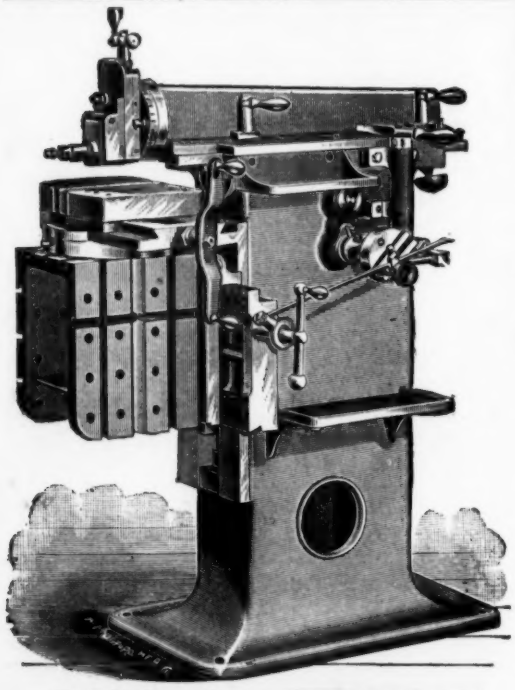

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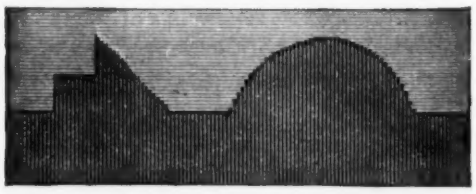

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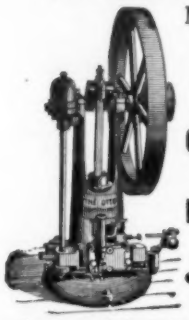

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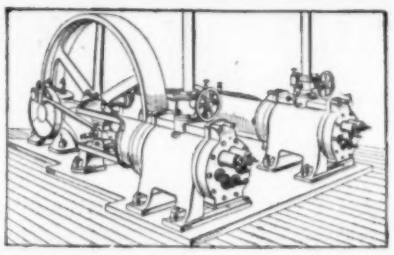

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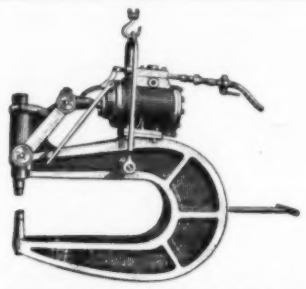

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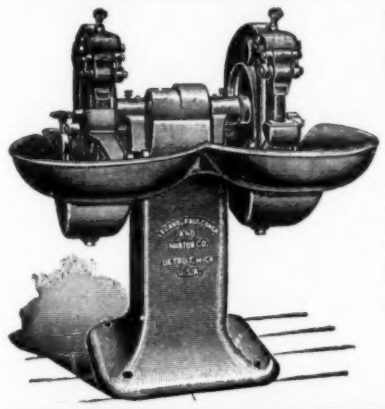

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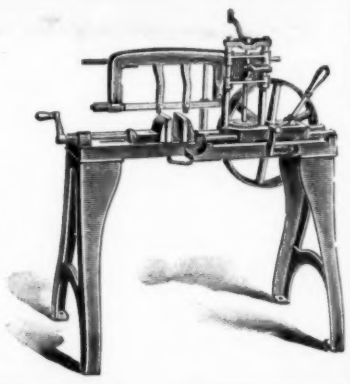

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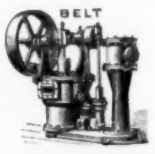

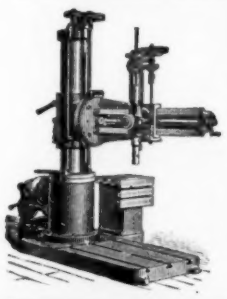

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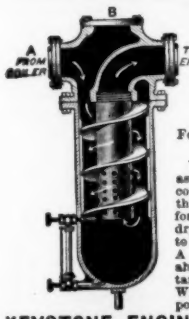

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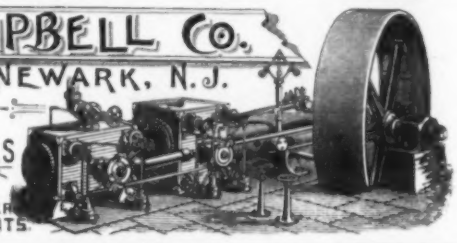

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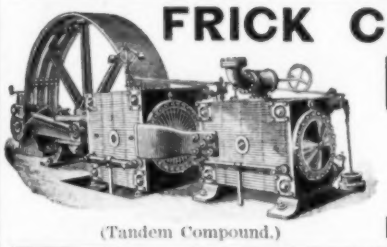

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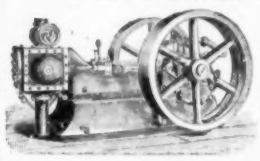

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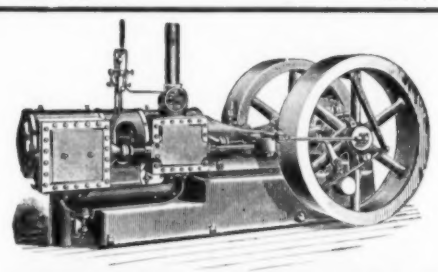

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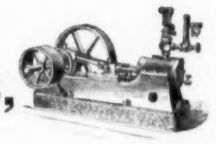

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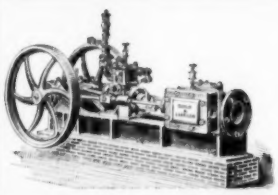

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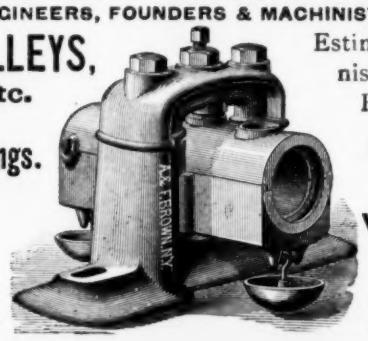

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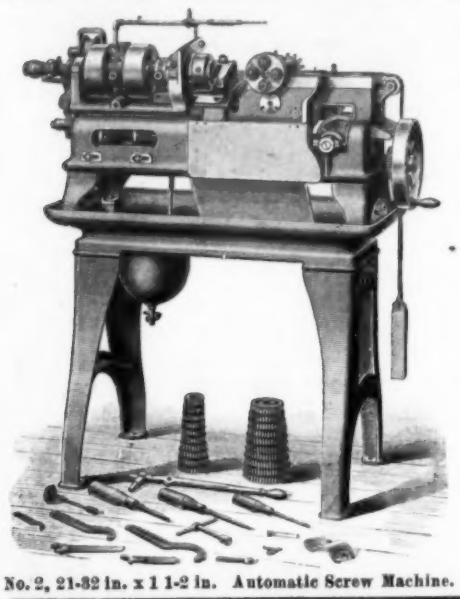

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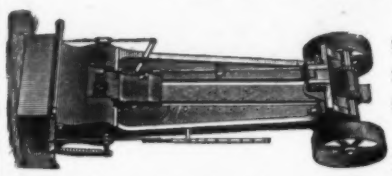

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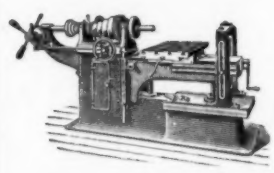

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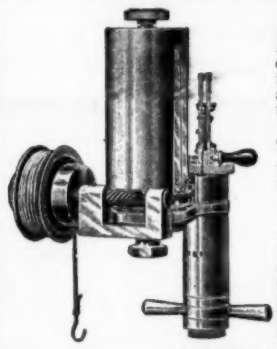

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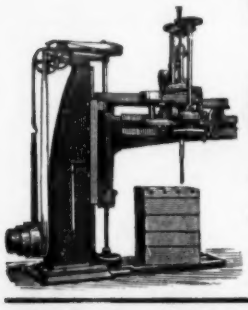

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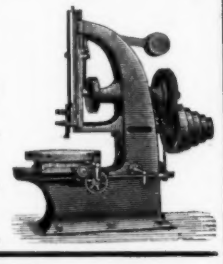

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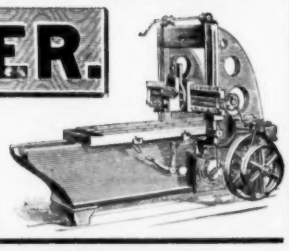

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